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BY

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PREFACE.

The present report is largely a compilation: in places a reprint, of the two summary reports on the region issued by the Department during the progress of the work, and published in the Summary Reports for 1910 and 1911. As geological work cannot be continued with advantage until the district is mapped, it has been considered advisable to assemble the results of the investigation up to the present, and publish them as a separate interim report. It includes reports on four neighbouring areas, all portions of the Skeena mining district. The main report deals with Portland Canal mining division; the others describe results of preliminary work in the Salmon River valley, portions of Nass valley, and on Observatory inlet.

PART I.

PORTLAND CANAL DISTRICT

BY

R. G. McConnell.

PART I.

PORTLAND CANAL DISTRICT.

CHAPTER I.

INTRODUCTORY.

GENERAL STATEMENT.

The field work on which the report is based, occupied the season of 1910 and a portion of that of 1911. The field season in the district is short, as the upper slopes of the mountains are usually covered with snow until late in July, and towards the end of September mountain climbing is practically stopped by the constant rains.

Mr. A. O. Hayes acted as geological field assistant during both seasons, and Mr. G. G. Gibbons during a portion of that of 1911, and both carried out all duties entrusted to them with energy and judgment. A report on a collection of thin sections of the typical rocks of the district was also made by Mr. Hayes, and is used in the descriptions.

The topographical base of the geological map of Portland Canal mining district, which accompanies the report, varies in value in different portions. The lower portion of Bear River valley, Glacier and Bitter creeks, and the adjoining mountains and mountain ranges, were carefully surveyed by Mr. Malloch, who acted as topographer during the season of 1910. The Salmon River and Cascade River valleys—with the exception of some alterations along the latter—are taken from the maps published by the International Boundary Survey. The eastern part of the map sheet is based only on sketches and a few rough track surveys; and while showing in a general way the main topographic features of the eastern portion of the Coast range, hitherto unmapped, has no pretensions to accuracy in detail.

PREVIOUS WORK.

While no work had previously been done by the Geological Survey in the district, three reports have been published by the British Columbia Bureau of Mines. Two of these, by Mr. H. Carmichael, Provincial Assayer, are included in the annual reports of the Bureau of Mines for 1906 and 1909 respectively, and one by Mr. W. F. Robertson, Provincial Mineralogist for British Columbia, was published in 1910, as Bulletin No. 2.

ACKNOWLEDGMENTS.

The writer is indebted to most of the mining men in the district for information and other courtesies: and especially to Mr. C. M. Dickie, president, Mr. Elmendorf, manager, and Mr. Sheridan, mine superintendent of the Portland Canal Mining Company; Mr. A. Erskine Smith, president, and Messrs. Webster and Smith, mine superintendents of the Red Cliff Mining Company; Mr. A. D. McPhee, manager of the Red Cliff Extension and other mining companies; Mr. H. B. Williams, engineer for the Lordigordy Mining Company, etc.; Mr. T. I. Vaughan-Rhys, engineer for the Main Reef Mining Company, etc.; Mr. Tuomy, mine superintendent of the Stewart Mining and Development Company; Mr. Knobel, manager of the Pacific Coast Exploration Company; Mr. Smith, manager of the International Portland Mining Company; Mr. Baxter, mine superintendent of the Main Reef claim; Mr. James Lydden, part owner of the Old Chum and other claims; and Mr. Anderson of the Black Bear group.

SITUATION AND COMMUNICATION.

The district is situated in northern British Columbia, close to the Alaska boundary, at the head of Portland canal: one of the largest of the numerous fiords which indent the North Pacific coast. Portland canal cuts completely across the long granitic batholith which forms the central portion of the Coast range, and reaches the mineralized sedimentary and volcanic rocks which here border the batholith on the east. Bear river empties into the canal at its head, and the area reported on includes the portion of the mineralized belt drained by that stream and its tributaries.

Portland canal is a large deep inlet, easily navigable by the largest steamers. Stewart—the distributing point for the district—is situated at its head, and several steamship lines maintain regular communication between it and Prince Rupert, Vancouver, and other coast towns.

A railway has been built from Stewart up Bear River valley to the Redcliff mine, a distance of 11 miles; and a wagon road to the same point under construction by the Provincial Government is nearly completed. A number of trails following the tributary valleys, and in places climbing the steep mountain slopes, connect the principal showings with the wagon road.

DISCOVERY.

The metalliferous character of the Portland Canal mining district was first discovered by a party of prospectors in 1898, the year of the great Klondike rush. They were searching for placer deposits, but failing to find pay gravels turned their attention to prospecting for quartz. The Roosevelt and other claims on the North fork of Bitter creek were staked in 1899, and the Mountain Boy and American Girl on American creek in 1902. The Alaskan boundary at that time had not been defined, and the claims were first staked under United States laws, but were subsequently restaked and recorded in British Columbia. The Redcliff, which could hardly escape notice as the croppings show up prominently on the mountain side, was first staked in 1898, and has lapsed and been restaked several times, the last time in 1908.

While some prospecting and staking were done year by year, little actual mining work was attempted until 1907, when the Portland Canal Mining Company commenced development work on the Little Joe and Lucky Seven claims on Glacier creek. The success met with drew the attention of miners to the district, and during the last three or four seasons, prospectors have swarmed over it, and little ground from Stewart far up Bear River valley, which shows any signs of mineralization, is now left unstaked.

TOPOGRAPHY.

The Portland canal mining district is situated in the heart of the Coast range, in a region of intense glaciation, and its topography, while still bold and striking, has been toned down by moving ice, and much of the original ruggedness removed. It has been heavily glaciated up to a height of fully 5,500 feet above the sea, and the mountain slopes, below this level, although usually very steep, often rising in sheer unscalable cliffs, are, as a rule, comparatively smooth, except where scored and broken by narrow canyons carved out, in post-glacial time, by streams plunging down from the perennial snow and ice fields above.

The dominant features of the mountain landscape, viewed from one of the higher elevations, are the steep valley slopes, the

jagged peaks of the Cambria range, and the prevalence above an elevation of 4,500 feet of vast fields of snow and ice. These in places terminate in long lines of ice cliffs from which huge masses are constantly falling, but more commonly form glaciers which descend the mountain slopes for some distance, and are then replaced by roaring torrents often deeply trenched in rocky canyons.

RELIEF.

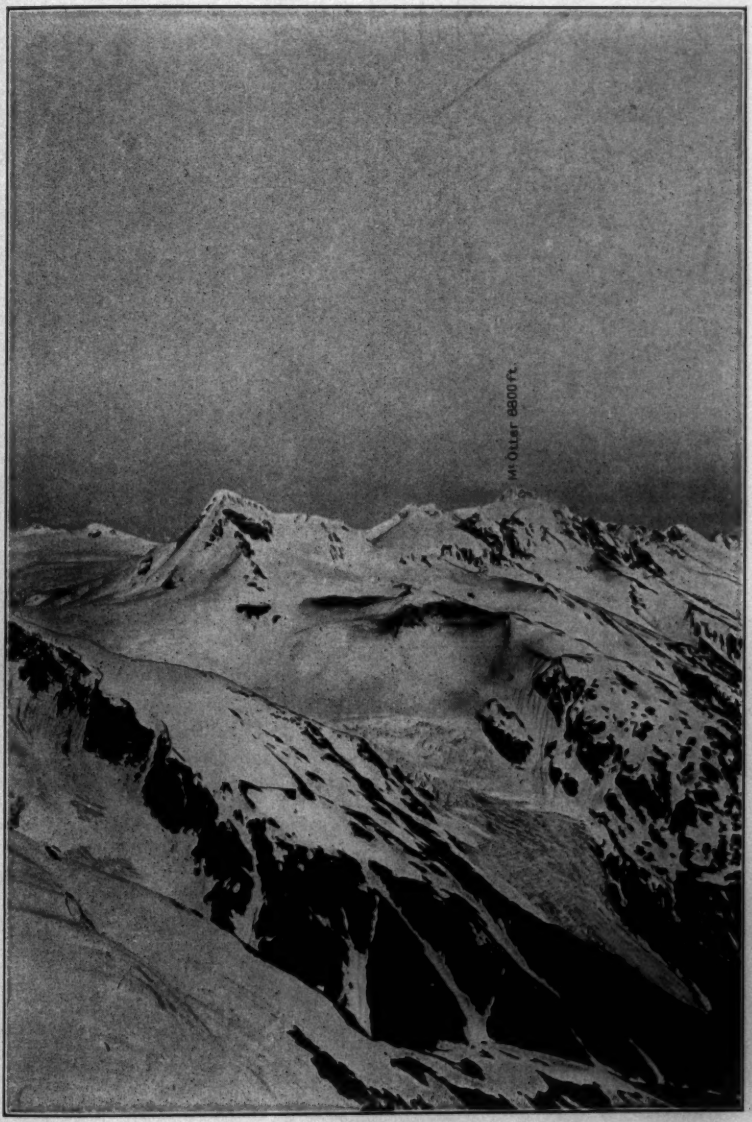
The district embraces a number of high mountain groups and mountain ridges, separated or partially separated by the deep valleys of Bear river and its numerous tributaries, but usually coalescing around the heads of these streams.

The principal mountain divisions include the long, rather even ridge separating Bear river and its tributary American creek from the Salmon, which I have called the Bear River ridge; a group of mountains between American creek and the upper part of Bear river; a range of high sharp peaks known as the Cambria range[1] northeast of the Bromley glacier; a broken ridgy group culminating in Mt. Gladstone between the north fork of Bitter creek and Bear river, and a group of high, snow covered, rather flat topped elevations between Bitter and Glacier creeks, for the highest point of which the name Mt. Dickie[2] is proposed.

The Bear River ridge has a general elevation of 5,000 feet, but is surmounted by a number of irregularly distributed rocky knobs and peaks some of which attain elevations of over 6,000 feet. The ridge, while deeply gashed by streams flowing eastward to Bear river and American creek, and westward to the Salmon and Cascade rivers, is not interrupted by low passes, and extends northwards unbrokenly from the mouth of the Salmon to the watershed range a distance of over 20 miles. The northern part of the ridge is covered by a nearly continuous snow-field.

The group of mountains between American creek and upper Bear river are practically a southward spur from the watershed range. Mt. Johnson, a rounded, rocky knob, conspicuous looking up Bear River valley, has an elevation of 5,000 feet, and a line of peaks farther to the north along the watershed attain heights of over 6,000 feet. At their feet is a wide, irregular snow-field edged with numerous glaciers creeping down towards the deep bordering valleys.

[1] Name proposed by miners interested in the vicinity.
[2] After the President of the Portland Canal Mining Company.



Cambria range.

East of the upper Bear river is Mt. Gladstone, a snow covered ridge with projecting rocky points, the highest rising to an altitude of 6,800 feet. North of Mt. Gladstone and extending across the watershed is a broken snow covered region falling towards Bear River valley in a series of cliffs so steep that so far they have defied exploration.

The Cambria range extending in a southeasterly direction from Mt. Gladstone, between the Bromley glacier and the Cambria valley, is the highest and most impressive range in the district, Mt. Otter the central point, reaching an altitude of 8,800 feet. The peaks unlike those in the other ranges are sharp and jagged, a type more characteristic of the Rocky mountains than of the Coast range. They project through a long continuous snow-field fringed below on both slopes by narrow glaciers.

The mountain mass between Glacier creek and Bitter creek and the Bromley glacier rises in easy slopes from Glacier creek and Bear river but presents an exceedingly steep face towards the Bromley glacier. The upper surface is unusually even but is surmounted by a few low peaks, the highest, Mt. Dickie, having an elevation of 6,400 feet. A wide snow-field extends southeastward from Mt. Dickie towards the Bromley glacier, edged as usual with frequent glaciers.

A section across the Coast range in the vicinity of Portland canal and Bear river shows a gradual although irregular increase in the heights of the mountains going eastward towards the watershed ranges of about 2,000 feet. The watershed ranges are situated close to the eastern margin of the Coast mountains and from them the surface slopes quickly down towards the ridgy district bordering the Nass on the west. The steep eastern slope is an unusual feature of the range as along a large portion of its course the adjoining country is high and its eastern edge is marked more by increasing ruggedness than by a sudden decrease in elevation.

In the western or granitic portion of the Coast range, the mountains are very uniform in height, the variation seldom much exceeding 1,000 feet. The eastern portion built of argillites and greenstones of varying hardness, shows greater diversity, the peaks ranging in height from 6,000 to nearly 9,000 feet. The difference is doubtless due to the change in geological conditions. No evidence of a former general peneplanation of the range was observed, and if such a condition ever obtained, all traces of it have been removed by subsequent erosion.

DRAINAGE.—The district is drained entirely by Bear river and its tributaries. Bear river is a swift mountain stream about 18 miles in length. It heads with Strohn creek, a branch of the Nass, in a low pass covered with a short glacier at an elevation of 1,370 feet. In the lower part of its course below American

creek it is a wide winding stream flowing rapidly in a network of channels around gravel bars and low islands which are being constantly built up and destroyed. At one point, a mile above Bitter creek, it passes through a short canyon evidently a new channel excavated in post-glacial time. The old channel is blocked by a deposit of estuarine clays and sands over 500 feet in thickness. Above American creek, Bear river is usually confined to a single boulder paved channel from 40 to 75 feet in width. Its grade in this portion of its course averages about 100 feet to the mile.

The principal tributaries are Glacier creek and Bitter creek from the southeast and American creek and Cullen creek from the northwest.

Glacier creek is a short, rapid stream, from 20 to 50 feet in width, formed by three glacier fed branches. The trunk stream has a length of 2½ miles, and is sunk in a deep, narrow canyon throughout its whole course.

Bitter creek joins Bear river 8½ miles from its mouth, and is the largest stream entering it, probably carrying more water at ordinary seasons than the main river. It has a length of 6 miles to its main source in the Great Bromley glacier, and a fall averaging 100 feet to the mile. It is a wild stream, the swift current and boulder strewn channel making it practically one long rapid.

Four miles above Bitter creek, Bear river bends to the east, and is joined by a large branch from the north, known as American creek, the two forks being nearly equal in size. Only the lower portion of American creek was examined. It is longer than Bear river, and is fed by numerous glaciers, one of which, about 7 miles above its mouth, crosses and blocks the valley.

Cullen creek, a short, steep graded stream heading in a large glacier, enters Bear river 1½ miles below the summit glacier. Its flow is larger than Bear river above the junction.

In addition to the large tributaries described, the mountain sides are furrowed everywhere by a multitude of roaring torrents cascading down the steep mountain sides, and few places in the district are free from the sound of falling water.

Valleys.— The Coast range is cut transversely by a continuous valley now occupied in turn by Portland canal, Bear river, and Strohn creek. The latter separated from Bear river by a low pass, flows eastward to the Nass.

Bear River valley below Bitter creek is a deep, steep sided, flat-bottomed, typically ice worn trough partially filled up with gravel and sand. Portland canal, its direct continuation, represents a flooded portion of the same valley due to a general depression which affected the whole north Pacific coast. Moving ice has smoothed and steepened the sides and probably added

slightly to the depth, but there is little doubt that Bear river or its precursor in preglacial times was the main factor in its excavation.

Bear River valley maintains its flat-bottomed character up to the mouth of American creek and for a short distance beyond, except along a short stretch above Bitter creek where a heavy deposit of estuarine clays and sands diverted the stream to the west and forced it to cut a new channel.

Above American creek, Bear River valley bends to the east, becomes much narrower, and at one point passes into a canyon known as the Bear River canyon. The valley bottom above the canyon is usually from 200 to 500 yards in width and is lined in places with low gravel terraces.

The valley of American creek is wider than that of Bear river above the junction. It is a long U-shaped depression gradually rising up and terminating in the high flanks of the watershed range. The bottom is lightly covered with drift, and in places the stream is enclosed in narrow rock-walled canyons sunk through the old floor.

The valley of Bitter creek, except near the mouth and in the vicinity of the north fork, is narrow, and, in places, is badly blocked in the early season of the year by snow slides.

The Bitter Creek valley above Bitter creek is occupied by the Bromley glacier. This glacier is largely fed from a long snow-field, filling a depression which I have called the Cambria valley, as in its northern extension it borders the Cambria range on the east.

The snow filled Cambria valley is an important and also a somewhat peculiar feature of the Coast range. It has a width of from 1½ to 2 miles, and a known length of 20 miles, and may be much longer, as its southern extension has not been explored. It crosses the watershed range at a small angle, its direction being slightly diagonal to that of the main range. To the north, it terminates in the Nelson glacier descending eastward towards the Nass; while midway in its course, a gap in the bounding mountains allows the accumulated snows to escape westward as a branch of the Bromley glacier which flows towards the Pacific. The southern portion probably finds an outlet towards Hastings arm of Observatory inlet.

The snow surface of the valley is high, averaging over 5,000 feet, and between the Nelson and Bromley glaciers rises to a flat summit at an elevation of 5,750 feet. The snow and ice filling is evidently very deep, and hides everywhere the rock surface.

The origin of this deep depression crossing the axis of the range diagonally at a high elevation is not clear, and needs further study.

PASSES.—The principal pass through the Coast range in this portion of its course is the Bear River–Strohn Creek divide. This has recently acquired importance as a possible railway route to the Groundhog anthracite basin, at the headquarters of the Skeena, Nass, and Stikine rivers.

The pass is covered with a glacier about 1½ miles in length, made up of two arms flowing in opposite directions, one eastward towards the Nass and the other westwards down Bear River valley. The glacier is fed by a long ice stream occupying a trough which extends southward along the axis of the range, a group of high snow covered mountains still unexplored.

The Bear River arm of the glacier terminates at an elevation of 1,370 feet and the Strohn creek or eastern arm at an elevation of 1,540 feet. The ice summit has an elevation of 2,270 feet measured with the aneroid.

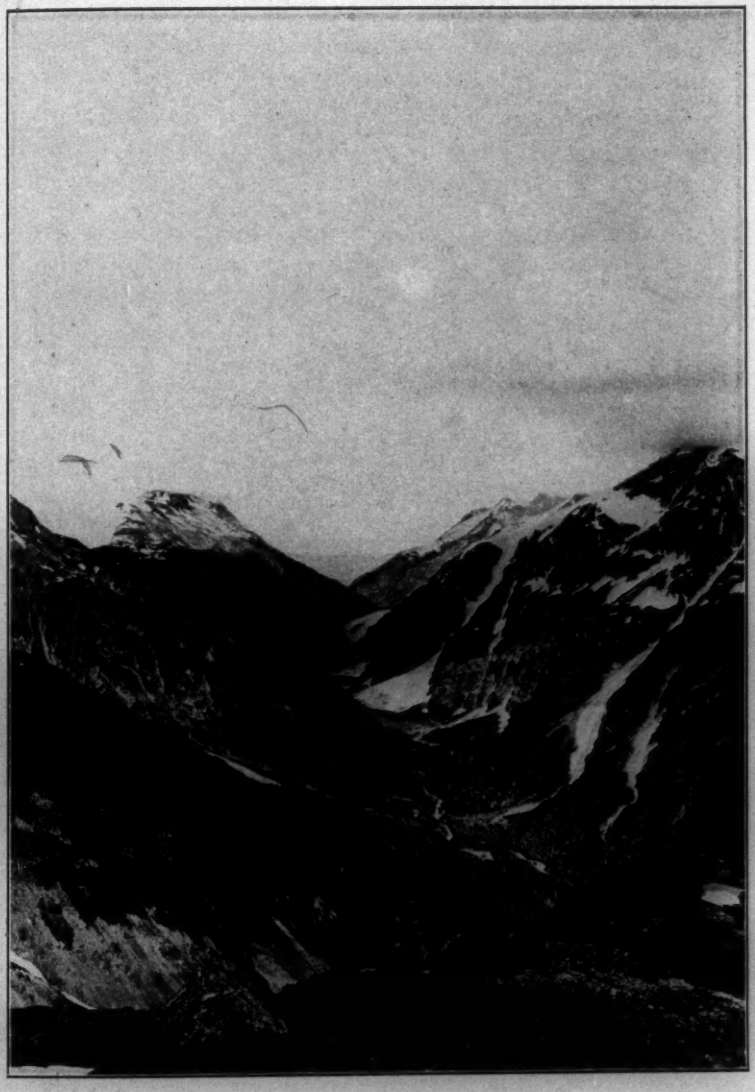
Bear River valley has a length from its junction with American creek to the foot of the summit glacier, of about 9 miles. It is flat-bottomed except along one stretch three-fourths of a mile in length, where it contracts into a V shaped canyon. Strohn Creek valley is flat-bottomed throughout, and offers no especial difficulty to railway construction. The grades of both valleys average about 100 feet to the mile.

The total length of a railway from the mouth of American creek, the present railway terminus to the Nass river following Bear river, Strohn creek and its continuation Meziadem lake, would be approximately 32 miles. A tunnel 1½ miles in length under the summit glacier would be necessary and possibly a short one at the Bear River canyon. A railway to the same point from Nasoga bay following the valley of the Nass would have a length of at least 110 miles.

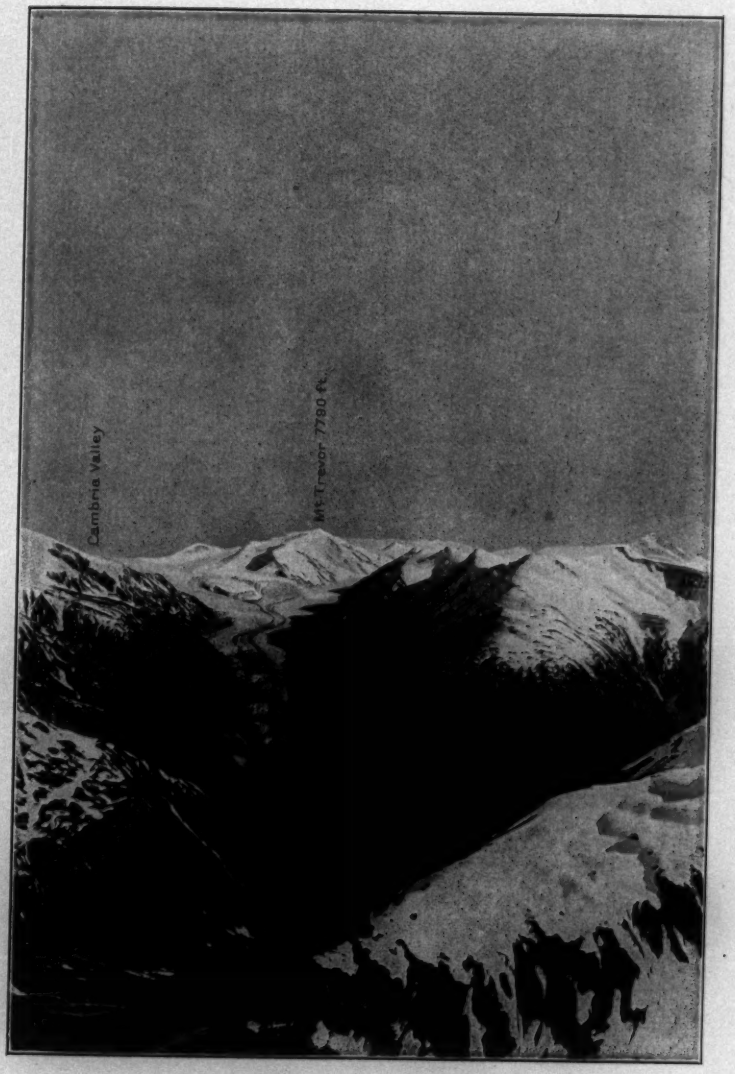
A second route across the Coast range, used to some extent by prospectors going to Porter and Willoughby creeks, is up Bitter creek to the Bromley glacier, then up the glacier to McAdam point near the southern end of the Cambria range. From this point the route leads up a steep ice slope 1,000 feet high to the level of the Cambria valley, then northward along the valley over a flat snow summit 5,750 feet high to its termination in the Nelson glacier and down this to the Nass valley. The Porter Creek glacier south of the Nelson glacier can also be used to descend to the Nass valley.

This route is largely over ice and snow, and late in the season when the glaciers become badly crevassed, portions of it, especially on the Nelson slope, are very dangerous.

GLACIERS.—The uplands of the district, except on the steep slopes, are largely covered, above an elevation of from 4,500 to 5,000 feet, with permanent fields of ice and snow. These form numerous glaciers, which fill the upper part of most



Bear river, Strohn Creek pass.



Bromley glacier.

of the valleys of the district and creep down the mountain slopes for varying distances; few of them reaching the main valley bottoms and most of them terminating at elevations of from 2,500 to 4,000 feet above the sea.

The largest glacier in the district is the Bromley glacier, the source of Bitter creek, the principal tributary of Bear river.

The Bromley glacier is formed by three main branches, two cascading down from the long Cambria valley snow-field, while the third swinging southward, skirts the base of Mt. Trevor, a beautiful white peak almost completely mantled in snow and ice, and is reported to head in a high pass leading to Marmot river. Below the forks, the glacier flows down Bitter Creek valley for a distance of 6 miles with a width of from 3,000 to 5,000 feet, terminating at an elevation of 1,000 feet above sea-level. The surface, while rough in places, especially near the sides, is not badly crevassed and the glacier is easily ascended for several miles. The surface slope averages about 700 feet to the mile.

Some measurements were made by Mr. Hayes opposite Hartley gulch about a mile above the end of the glacier to determine its rate of flow. Four stakes were planted at intervals across the ice stream on September 18, 1910. On June 14, 1911, the average downward movement of the four stakes averaged 198 feet, the central stake having moved 199 feet. The rate increased slightly from the east to the west bank. The average daily rate of movement for this period amounted to 0·72 feet. On August 20, the positions of the stakes were again measured, the average movement measuring 67 feet, a daily rate of 1 foot. Assuming that this summer rate was maintained until September 18, the date of the first measurement, the total movement for the year would amount to 295 feet, an average of 0·80 feet per day.

The Bromley glacier in common with all the prominent glaciers in the district, notwithstanding its flow of nearly 300 feet a year, is slowly receding, the retreat during the past year amounting to fully 50 feet. That this recession has been in progress for some time is shown by the bare morainic hills and ridges which cover the valley bottom for a distance of fully half a mile below the termination of the glacier. Farther down there is a growth of shrubs and the ordinary coniferous forest begins at a point about 2 miles below the glacier.

The Bear River glacier covering the low pass from Bear river to Strohn creek, while much smaller than the Bromley glacier, is peculiar from its shape. The Bear River–Strohn Creek "through" valley here running east and west, is bounded on the north by a continuous range of high cliff-walled mountains. South of the pass directly opposite the summit, the mountains are interrupted by a deep valley extending southward practically

along the axis of the range. A long ice stream moving northwar down this impinges against the cliffs north of the pass an vides into two short arms, one flowing east towards the Nas and the other west down Bear river, the directions of both bein nearly at right angles to that of the feeder.

The Salmon River glacier which occupies the summit of a "through" valley, immediately north of the district reported on, repeats the same operation on a larger scale, the two arms approximating 8 miles in length. The ice in the western arm descends to an elevation of 480 feet.

Short glaciers terminating before reaching the main valley bottoms occur at frequent intervals hanging to the sides of all the large valleys on both slopes of the range.

FOREST.

All the valley bottoms of the Portland Canal district are well wooded, and the forest sweeps up the mountain slopes, except where cleared away by snow slides, to heights of from 3,500 to 4,500 feet, depending on the exposures. Stunted specimens of balsam and mountain hemlock were found at an elevation of 5,000 feet.

The principal tree in the valley bottoms and lower slopes of the mountains is a hemlock (*Ptsuga mertensiana*). It is a fair-sized tree, usually attaining a diameter of from 2 to 4 feet, and furnishes excellent mining timber. The Sitka spruce (*Picea Sitchensis*), which usually accompanies the hemlock, is a tall stately tree, some specimens seen measuring fully 6 feet across. The cottonwood (*Populus trichocarpa*) and a large alder (*Alnus Oregona*), are well represented along the flats. The yellow cedar (*Chamaecyparis nootkatensis*) occurs in a few places in the district, but no specimens of the red cedar were seen. On the higher slopes the trees mentioned above are replaced by balsam (*Abies amabilis*), and the mountain hemlock (*Ptsuga heterophylla*).

The forest is protected from destructive fires by the humid climate, and the timber resources are sufficient to meet the requirement of the district for many years.

FAUNA.

Only a few species of animals thrive in the district. The mountain goat is abundant in places, and it, with the black bear, the siffleur, an occasional wolf, the marten, and mink are the principal representatives of mammalian life. The heavy winter snowfall is probably responsible for the absence of the deer and other species usually common along the coast.

CLIMATE.

The situation of the Portland Canal district on the west slope of the Coast range, though some distance inland, places it within the rainy belt, and the precipitation, while not so excessive as in the outer ranges, is still very high, probably averaging over 100 inches per year. The best weather occurs as a rule in the late spring and early summer months. The two past seasons were exceptional in this respect, dry weather continuing well into September. The precipitation falls as rain in the valleys from early in April until near the end of October, and as snow during the rest of the year. The temperature is equable, as the summers are cool and in the winter the thermometer seldom drops much below zero.

Heavy snow slides, due to the excessive winter snowfall and the steep slopes, are common throughout the district in the late winter and spring months. These usually follow the valleys, but in places plunge directly down the mountain sides, destroying the forest in their course. At some of the mines and prospects the slides are at times a serious menace.

WATER POWER.

Large streams with steep grades, most of them fed from permanent ice and snow-fields, are available for water power in every part of the district. The supply during the greater part of the year is usually ample, but in the midwinter months the flow in most of the streams becomes greatly diminished. Power plants have already been installed on Glacier creek by the Portland Canal Mining Company and on Lydden creek by the Redcliff Mining Company.

CHAPTER II.

GENERAL GEOLOGY.

The Portland Canal mining district covers a portion of the Coast range extending from the head of Portland canal up Bear river, and is practically co-extensive with the rugged region drained by that stream and its tributaries. The irregular eastern edge of the long granitic batholith of the Coast Range forms roughly its western boundary. The batholith is bordered on the east in this latitude by two series of sedimentary, predominantly argillaceous beds, separated by a complex volcanic group made up of massive and fragmental greenstones. The three formations are cut by numerous dykes and satellitic stocks belonging to the period of the Coast Range granitic invasion, and are, therefore, pre-Cretaceous in age. No other evidence in regard to their position in the geological scale was obtained. Fragments of obscure fossils were found at a couple of points, but none perfect enough for even generic identification.

The formations are not badly altered except near intrusive masses and probably range from late Palæeozoic to Jurassic. It is impossible to correlate them at present with any known formations.

CLASSIFICATION OF FORMATIONS.

The rocks and rock formations have been classified tentatively as follows, in order of age:—

1	Superficial deposits	Alluvial gravels, sands, and silts Estuarine clays and sands Boulder clays, moraines, etc
2	Later diorite porphyry dykes	
3	Coast Range granitic and porphyritic rocks in stocks and dykes	Granites Grano-diorites Gabbros Diorite porphyry Quartz porphyry
4	Nass formation	Mostly argillites with some tufaceous sandstone
5	Bear River formation	Massive and fragmental greenstones
6	Bitter Creek formation	Argillites with some tuffs and limestone

BITTER CREEK FORMATION.

The Bitter Creek formation consists largely of a great series of dark argillites dipping to the west, considered to be in part at least, the oldest rocks in the district.

DISTRIBUTION.—The Bitter Creek argillites occupy in the district a roughly triangular shaped area, situated between

Bear River valley and the Cambria range and terminating to the north in Mt. Gladstone. The area has a width along the southern base of 9 miles, and extends northwards, bordered on both sides by the Bear River greenstones for 11 miles. The boundaries are irregular and the argillites are intruded at a number of points by augite porphyrite stocks and by granitic stocks and dykes belonging to the period of the Coast Range batholith.

Rocks.—The principal variety is a dark argillite, cleaved into a slate in places, but as a rule the principal partings follow the original bedding planes. The argillite is usually rather coarsely bedded, and exhibits varying degrees of alteration, in extreme cases passing into a glossy micaceous schist. The ordinary constituents are grains of quartz and feldspar scattered more or less densely through a fine grained mat mostly indeterminable, but partly made up of small scales of yellowish mica and a fine carbonaceous dust often arranged in parallel lines. Secondary quartz in grains and small lenses is abundant in most of the sections, usually associated with crystals and aggregates of pyrite. Less common constituents are grains of zircon and long slender needles of rutile.

The argillites in places have a striped appearance due to the rapid alternating of their layers with lighter coloured, coarser and more feldspathic bands. This variety is common south of the Bromley glacier.

Bands of massive greenstone usually badly altered, but probably of tufaceous origin, occur in places with the argillites. Thin sections show them to consist largely of broken feldspar, crystals and grains of quartz with calcite, chlorite, and other secondary minerals. Greyish crystalline limestone usually in small non-persistent bands also occurs occasionally interbanded with the argillites. The proportion of limestone present increases to the northeast and in portions of the Mt. Gladstone ridge it forms an important part of the formation.

Structure.—The strike of the Bitter Creek argillites is generally N.W.–S.E., and the dip is to the southwest or towards the Coast Range batholith. The angle of dip in the western portion usually approximates 45°. Going eastward, the angle increases and, in places, the beds have a nearly vertical attitude. This general uniformity of dip across the area covered by the formation results in some uncertainty in regard to the reference of the series as a whole to a position subordinate to the Bear River greenstones, as on the western slopes of the Cambria range they appear to overlie the latter at a high angle. This may be due either to a great overturn or to faulting, but no definite proof of either was obtained. The contact passes along the higher slopes of the Cambria range, is difficult, in places impossible to reach, and along the more accessible portions of its course is usually concealed.

There is little doubt that the western, and if the present dip is taken for a guide, the upper portion of the Bitter Creek argillites are older than the Bear River volcanics which adjoin them, as they underlie them at various points, and are interbanded with sheets of porphyrite. Volcanic action, however, as evidenced by occasional tufaceous bands, was in progress near by during the whole period of the accumulation of the Bitter Creek argillites, and it is quite possible that portions of the wide-spread volcanic series grouped together as the Bear River formation may be contemporaneous with or even antedate them in order of deposition. This point could not be satisfactorily determined in the small area studied and in the time at our disposal.

Economic Features.—The Bitter Creek argillites are traversed by a number of quartz veins and silicified zones irregularly mineralized with sulphides, mostly pyrite and galena, carrying gold and silver values. The Portland Canal fissure zone described in a later chapter contains a number of ore bodies, and considerable work has been done on it at a number of points.

BEAR RIVER FORMATION.

This is the most widely distributed formation in the district. In it is grouped a series of massive and fragmental volcanics many thousands of feet in thickness, evidently representing the product of a long continued period of volcanic activity. The rocks have a general greenish coloration except in a few areas where they are reddened by the oxidation of their iron content.

Distribution.—The greenstones of the Bear River formation practically surround the Bitter Creek argillites in the district examined except towards the southeast. They occur bordering the granite on the southern part of Bear River ridge and extend northward along the ridge to the summit and for some distance beyond. The group of mountains between Bear river and American creek is formed altogether of the Bear River greenstones, except at one point where they are overlaid by the Nass argillites. The rugged mountains south of upper Bear river east of Mt. Gladstone also consist largely of greenstone and a wide continuous belt extends southeastward along the watershed ranges to a point beyond the area mapped.

Rocks.—The rocks of the Bear River formation have a wide range, and include porphyrites of various kinds mostly of hyp-abyssal origin, volcanic breccias and agglomerates, tuffs, and occasional argillaceous bands. Small areas in various parts of the district have been silicified and altered into a cherty condition.

A marked feature of the formation is the general absence, except in the case of the argillite bands, not only of sharp, but in most cases even of observable contacts between the massive and fragmental members of the group. The massive porphyrites often show flow structure in thin sections, but no continuous sheets could be traced out. They appear to occur as a rule in irregular areas and either pass gradually into the fragmentals, or the contacts if originally sharp, have been obscured by the granitic invasion of the Coast Range batholith and bordering stocks, and the subsequent mountain making movements.

Massive porphyrites predominate in the southern portion of Bear River ridge. Going north and east the proportion of fragmentals increases and the mountains bordering upper Bear river and extending southward on both sides of the watershed are formed mostly of fragmentals of varying coarseness.

The porphyrites are dark greyish, medium grained, comparatively deep seated rocks. They usually occur in a massive condition but in places have been sheared into a coarse schist. The porphyritic texture is not prominent as a rule in hand specimens, but in places, especially along the upper slopes of Bear River ridge, a rock filled with conspicuous white feldspar phenocrysts alternates with the ordinary variety. A red variety due to a development of secondary red oxide of iron is conspicuous in a few areas.

A number of thin sections studied and reported on by Mr. A. O. Hayes, field assistant, show them to consist largely of plagioclase feldspar in two generations. In most of the sections examined the ferro-magnesian minerals are either absent altogether or present only in small quantities, and the rock consists largely of phenocrysts of plagioclase scattered through a fine grained base of the same mineral usually showing flow structure. In a few sections, the dark minerals are present in sufficient quantities to class the rock as an augite and less commonly a hornblende porphyrite. Grains of black iron ore usually titaniferous are present in most of the sections, and apatite in small well formed crystals is very abundant. The common secondary minerals are chlorite, calcite, epidote, leucoxene, and the red oxide of iron.

The fragmentals occur as tuffs and volcanic breccias and agglomerates. The tuffs are made up largely of feldspar crystals often broken, quartz grains, and minute rock fragments lying in a dark, fine grained mat, and are often difficult to distinguish in the field from the massive porphyrites. The breccias exhibit considerable diversity in character and probably originated in different ways. They consist mainly of angular porphyrite fragments, accompanied in places by slate, limestone, and rarely granite. The fragments vary in size from minute grains

up to masses several feet across, but are often very uniform in size over wide areas. The matrix in the specimens examined is altered and difficult to determine, but appears to be massive in some instances, although mostly clastic, and occasionally the rock has the appearance of having been crushed in place. The fragments are usually pressed closely together, but in some areas are widely separated and seem to have been thrown up and fallen back into a still liquid matrix.

Occasional dark argillaceous bands occur with both the massive and fragmental members of the Bear River volcanic group, apparently indicating that sedimentation occurred at intervals during the whole period of its accumulation. The bands are thin, seldom attaining a thickness of over 100 feet, and of little persistence. They have not been closely studied and it is possible that some of them may consist of fine tufaceous dust. A lenticular area crossing Bear River canyon shows an alternation of dark steeply tilted agillites with bands of breccia.

STRUCTURE.—The rocks of the Bear River formation usually occur in a massive condition, but in places, especially along American creek and in the Salmon River valley, have yielded to crushing, and a strong schistosity approximately parallelling the eastern edge of the Coast Range batholith and dipping towards it, has developed.

The fragmental varieties consist largely of angular greenstone fragments very similar in composition to the massive porphyrites, enclosed in a massive or pyroclastic matrix. They are seldom distinctly bedded or banded and are often remarkably uniform in composition through sections many hundreds of feet in thickness.

ECONOMIC FEATURES.—The rocks of the Bear River formation contain numerous mineral deposits usually in the form of lenses or irregular areas often of large size. Pyrite is usually the principal mineral present, but in places pyrrhotite is more abundant. The iron sulphides are usually accompanied by subordinate quantities of galena, chalcopyrite, and zinc blende. The gold and silver values are occasionally important.

AUGITE PORPHYRITES.

Areas of augite porphyrites occur in different parts of the district intruding the Bitter Creek argillites and in places continuing into the Bear River greenstones. They form distinct easily traceable masses where they cut the argillites, but where they enter the greenstones the boundaries become uncertain and in places they become brecciated and resemble common varieties of the Bear River rocks. The rocks in these areas

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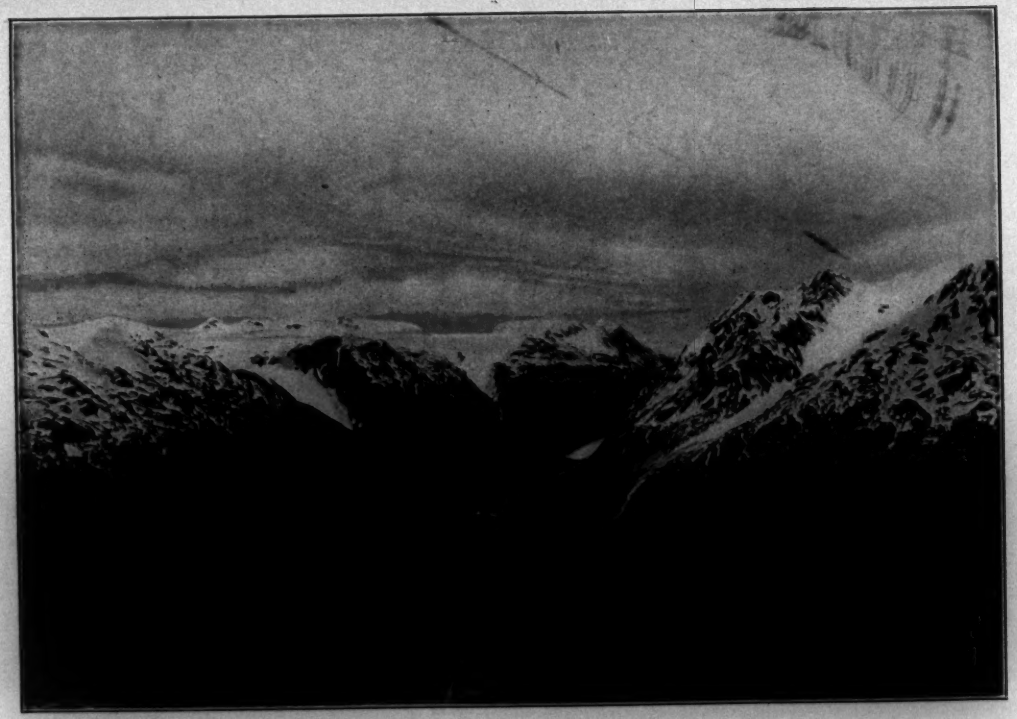

Bear River valley above American creek. Bordering mountain built of Bear River volcanics.

are similar to the augite porphyrites which occasionally develop in the Bear River formation and probably belong to its closing stages.

DISTRIBUTION.—A rounded area of augite porphyrite about 2 miles across, wholly enclosed in the Bitter Creek argillites, occurs at the head of Glacier creek, and a smaller elongated area outcrops less than a mile to the north along Maude gulch.

A long narrow area occurs east of the Bromley glacier and Bitter creek. This cuts the argillites in its southern extension but joins the Bear River greenstones in the north. A fourth area showing the same relationship to the argillites and greenstones crosses Bear river at the canyon.

ROCKS.—The augite porphyrites are dark greyish and greenish, medium textured rocks usually distinctly porphyritic in hand specimens. The principal phenocrysts are crystals of dark augite.

In thin sections they show phenocrysts of augite and plagioclase in a base of small lath shaped plagioclase crystals frequently showing flow structure. Black iron ore and apatite are the principal accessory minerals. Hornblende is occasionally present, usually as an alteration product from the augite. Other secondary minerals are calcite, chlorite, epidote, and occasionally quartz.

STRUCTURE.—The augite porphyrites in the areas on Glacier creek, Maude gulch, and north of the Bromley glacier occur in a massive condition. They are broken and fissured in places but as a rule are not strongly jointed. The area outcropping at Bear River canyon has been partly crushed into a coarse schist. The planes of schistosity follow the usual N.W.–S.E. direction and dip steeply to the S.W.

ECONOMIC FEATURES.—The augite porphyrite area on Glacier creek is traversed by a number of veins running in different directions and mostly filled with quartz. Small galena ore-shoots with some tetrahedrite carrying high values in silver occur in places. Other minerals present are pyrite, stibnite, and tennantite. Quartz veins carrying gold values also occur on Hartley gulch in the area north of the Bromley glacier.

NASS FORMATION.

The Nass formation consists of a thick argillite series alternating in places with coarse clastic beds and bands. These rocks definitely overlie the Bear River volcanics and in one place appear to alternate with them near their base.

DISTRIBUTION.—The Nass argillites were only found in the Bear River district in isolated areas along the summit range. They occur here overlying the Bear River greenstones on the

summits of mountains situated north and south of Bear River pass. East of the Coast range they occupy the ridgy district extending eastward from the mountains to the Nass river and probably extend for some distance beyond.

ROCKS.—The Nass formation consists largely of dark argillites, very similar in most respects to those of the Bitter Creek argillites, but less generally altered. They are seldom strongly cleaved, and in some sections might be classed as shales. Beds and thick bands of tufaceous sandstones occur with them in places, but are of subordinate importance. These consist of angular and subangular grains of quartz and broken feldspar crystals, with occasional small rock fragments, mostly slate and limestone, enclosed in a dark fine grained matrix, usually considerably altered.

The bands are, as a rule, homogeneous throughout, showing no stratification or sorting, and may in some cases at least represent true air borne tufaceous deposits.

In the mountain north of Bear River summit the Nass argillites alternate near their base with heavy bands of volcanic greenstone breccia precisely similar to that occurring in the upper portion of the underlying Bear River formation.

STRUCTURE.—In the summit ranges the Nass argillites occur in a nearly flat attitude or undulating in light folds, while along the eastern edge of the Coast range the inclination is steadily eastward. The angle of dip is 45° along the contact with the Bear River greenstones but gradually diminishes going eastward. In a previous paragraph, the Bitter Creek argillites are stated to have prevailing westerly or southwesterly dips, thus giving the two formations the appearance of forming opposing limbs of a wide syncline separated by the Bear River volcanic area. They were not found in juxtaposition and the principal reason for classing them as two series is that while the Nass argillites definitely overlie the Bear River volcanics, the Bitter Creek rocks appear to underlie them to the west, and are intruded by them at various points. The lithological character of the two formations, also, while generally similar, exhibit some differences. Limestone occurs in the Bitter Creek formation and the proportion of coarse fragmental rocks is much less than in the Nass formation.

ECONOMIC FEATURES.—No mineral occurrences have so far been found in the rocks of the Nass formation in the Portland Canal district. On the east slope of the Coast range, small quartz veins occur in the formation at the head of Porter creek and considerable prospecting is now going on in that vicinity.

GRANITIC AND PORPHYRITIC ROCKS.

The district reported on lies immediately east of the Coast Range batholith, and satellitic stocks and apophyses from it in the form of dykes often of large size, everywhere intrude the older rocks. The petrology of these presents great variety, the rocks ranging in acidity from quartz porphyries through granites and grano-diorites to gabbros.

DISTRIBUTION.—The eastern edge of the Coast Range batholith crosses the southwestern corner of the district, and granitic rocks form the mountains bordering the lower portion of Bear river on the west. The eastern boundary of the batholith has a general N.W.-S.E. direction but is irregular in detail. Near the mouth of Bear river, a wide spur from the main area crosses the valley and extends eastward up Barney gulch for a distance of 2 miles.

The principal outlying area in the district occurs in the form of a band usually from half a mile to a mile in width traceable from Mt. Dickie northwestward down Bitter creek to Bear River valley and up Goose creek and across the Bear River ridge to the Salmon valley. Near the head of Goose creek, the band consists of a series of wide parallel dykes. Similar dykes outcrop in the steep mountain slopes bordering the Bromley glacier on the west and probably represent an extension of the band southeast from Mt. Dickie.

Small stocks of varying mineral composition are numerous in the mountains between Glacier and Bitter creek, in the long ridge extending from Mt. Gladstone to Bitter creek, and in places along Bear River ridge.

ROCKS.—In the main batholithic area along the lower portion of Bear river, the principal variety present is a coarse grained, greyish granite made up of large rounded quartz grains, orthoclase and plagioclase in about equal quantities, brown biotite and some green hornblende with accessory titaniferous black iron ore, apatite, and sphene. In the small outlying stocks, the principal variety is more basic and is classed as a grano-diorite or where porphyritic as grano-diorite porphyry. The ordinary constituents are plagioclase feldspar, usually but not always some orthoclase, quartz, biotite, and less frequently hornblende. With these as accessory minerals are titaniferous iron ore, apatite, and sphene. The principal secondary minerals are calcite, chlorite, muscovite, and leucoxene.

A diorite porphyry made up of large phenocrysts of plagioclase and hornblende in a fine grained altered groundmass occurs in a small stock on Bear River ridge north of Mt. Dolly.

The rocks in the wide band extending northwest from Mt. Dickie across Bear River valley and Bear River ridge vary

widely in character. The ordinary variety is a medium grained, greyish grano-diorite, usually more or less porphyritic in thin sections. Portions of the band are, however, very acid, and show gradations ranging from a quartz porphyry to a quartz diorite porphyry. The more acid phases are occasionally entirely destitute of dark minerals, some sections consisting of large angular quartz phenocrysts and aggregates of quartz grains in a moderately fine grained base of quartz and orthoclase. In hand specimens, this variety resembles a quartzite. From it, the series of sections show a gradually increasing basicity; well formed hornblende crystals appear, plagioclase phenocrysts replace largely or altogether the quartz and orthoclase, and in the last stages the rock passes into a diorite porphyry.

Three stocks consisting mostly of gabbro, the largest about a mile across, occur intruding the Bitter Creek argillites between Glacier and Bitter creeks. Small stocks of the same rock also occur south of Glacier creek and at the mouth of Hartley gulch east of the Bromley glacier.

In hand specimens the gabbro is a dark, coarse grained rock filled with large augite crystals. In thin sections it shows plagioclase in large individuals or in aggregates of large plates with broad albite twinning, abundant fresh pale green augite, and usually some biotite. With these as accessory minerals are apatite and black iron. The usual secondary minerals are chlorite, calcite, epidote, leucoxene, and saussurite.

Economic Features.—The granitic and allied rocks while fractured and mineralized at a few points do not contain so far as known any deposits of commercial importance.

DYKE ROCKS.

The dyke rocks of the district belong mainly to two groups, one preceding and the other following the mineralization of the district.

Earlier Dykes.—These dykes are genetically related to the granitic rocks and were intruded during or possibly in some cases immediately after the granitic invasion. They occur throughout the district cutting the Bitter Creek, Bear River, and Nass formation. They generally follow more or less closely the bedding planes of the sedimentaries, but in places cut directly across them. They are usually large, often 30 feet or more in width, and traceable for long distances. On Bitter creek, especially along the southwest side of the Bromley glacier, a succession of large grey dykes alternating with the dark argillites of the Bitter Creek formation, and running nearly horizontally along the steep valley walls, forms a conspicuous feature of the landscape.

The dyke rocks of this period are less variable in character on the whole than the stocks. Ordinarily they are light greyish, medium textured feldspathic rocks, usually only feebly porphytitic in hand specimens. In thin sections the porphyritic structure is more pronounced and they are classed generally as diorite porphyries. The minerals present consist of plagioclase, with biotite, hornblende, and augite, either separately or together, and frequently a small quantity of interstitial quartz. Dark iron ore and sphene are common accessories.

Acid dykes ranging from granite to quartz porphyry, occur occasionally but are less numerous than the more basic type. No pegmatite dykes common along other portions of the Coast range were observed.

Later Dykes.—The dykes of this group are very numerous but are smaller as a rule than the older set. They are the latest intrusives in the district and cut all the older rocks and also some of the veins and mineral deposits. They are sharply discriminated in this respect from the older dykes, as these were intruded before the district was mineralized and are themselves silicified and mineralized in places.

The later dykes are darker coloured, more basic on the whole and somewhat finer grained than the older set, but are closely related to them mineralogically. A study of a number of thin sections by Mr. Hayes led him to class them as diorite porphyries. The principal constituents, as in the older set, are plagioclase with varying quantities of biotite, hornblende, and augite. Some interstitial quartz is occasionally present.

The later dykes are not mineralized except by scattered grains of pyrite. In many instances they cut directly across veins and ore bodies without noticeable effect on either themselves or the deposit intruded.

SUPERFICIAL DEPOSITS.

The superficial deposits of the district include boulder clays and morainic material, estuarine clays and sands, and alluvial gravels, sands, and silts.

Boulder Clays, Etc.—The boulder clay deposits of the Glacial period have been buried in the lower portion of Bear River valley beneath alluvial gravels and sands, and on the upper portion and on the tributary valleys have been largely destroyed by the rapid streams. Thick exposures occur on Bear river below Bear River canyon and on Bitter creek in the vicinity of the North Fork. Ascending these valleys the irregularly distributed boulder clay is gradually replaced by loose morainic material deposited by the receding present glaciers.

On the mountain slopes and summits occasional moraines, formed during halts in the recession of the great glacier, occur up to a height of 5,000 feet, while scattered erratics were found at an elevation of 6,000 feet. It is probable that the whole range at the time of maximum glaciation, with the exception of the high Cambria peaks, was buried in ice and snow.

ESTUARINE DEPOSITS.—Bluish and yellowish clays occur along Bear river above its junction with Bitter creek, along Bear lake, and are also exposed on the sides and summit of a wide ridge 485 feet high partially blocking the valley above Bear lake. The clays are usually bluish in colour in depth, but often weather yellow near the surface and as a rule are very plastic. Bands of yellowish and greyish sands occur in places and layers of pebbles are occasionally present. In some of the exposures, pebbles and small rounded boulders occur scattered irregularly through the mass, giving it the appearance of a boulder clay. The maximum thickness of the depo it is estimated at 155 feet.

These clays were supposed to be of lacustrine origin when first examined, and are so referred to in the Summary Report of the Survey for 1910, but during the past season, marine shells were found in them at several points and there is no doubt that they represent an estuarine deposit.

The principal shell locality occurs in a cutting on the Portland Canal Short Line railway above the second crossing of Bear river about 10 miles from tide water at the head of Portland canal. The shells, which consist mostly of fragments of a large barnacle, and a brachiopod, *Terebratella transversa*, both still living in the neighbouring seas, are present in the clay and also occur attached to the smooth glaciated rock exposed in the cutting. They occur at elevations of from 343 feet to 348 feet above the present mean tide.

Blue clays holding broken marine shells occur along Bear lake at an elevation of 340 feet, and similar clays without shells and interbanded with sands occur a mile farther up the valley up to an elevation of 485 feet.

The clays and the associated sandy and gravelly beds are very similar to those now being deposited at the head of Portland canal, and their presence 10 miles above the present tidewater and at an elevation of nearly 500 feet above it, proves a post-glacial elevation of the land of at least 500 feet. The full elevation was not ascertained as the beaches of the period, if any were formed, have been entirely destroyed. Evidences of a similar elevation occur on Texada island and other places along the Pacific coast.

ALLUVIAL DEPOSITS.—Bear River valley below its junction with American creek, except for a short stretch above Bitter

creek, is bottomed by wide flats built of gravel and the fine detritus brought down by the present drainage system. The flats seldom have an elevation of more than a few feet above the water level, and the loose material of which they are formed yields easily to the attacks of the impetuous winding stream. Portions are being constantly undermined and destroyed and the position of the stream channels is continually shifting, entirely new ones being frequently formed.

An extension of the flats seaward is now in progress. Erosion in the district by moving ice and water and atmospheric agencies is exceptionally active and Bear River, the trunk stream, is loaded with sediment obtained from various sources throughout the greater portion of the year. The material brought down finds a resting place in Portland canal and the head of this inlet is being gradually silted up to water level.

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CHAPTER III.

ECONOMIC GEOLOGY.

MINERAL DEPOSITS.

The mineral deposits of the Portland Canal district occur mostly in the Bitter Creek argillaceous and Bear River volcanic formations, but are not restricted to these two series, as fissuring accompanied with mineralization occurs in the Nass argillites, in the grano-diorite stocks, and to a greater extent in the augite porphyrite areas, especially the one at the head of Glacier creek. The whole region in fact, at the close or shortly after the termination of the Coast Range granitic invasion, seems to have been crushed, fissured, and penetrated at innumerable points by siliceous and metal bearing solutions from the dying batholith. The resulting mineral deposits, while remarkable from their great number and wide distribution, are in the majority of cases bunchy and uncertain, and even where of considerable size only occasionally contain valuable minerals in sufficient quantities to hope for profitable extraction.

CLASSIFICATION.

The deposits may be generally grouped into two classes: (1) veins and fissure zones; (2) replacement deposits. The two groups are not, however, except in extreme cases, sharply discriminated and examples occur which might be referred to either. Replacement often plays an important rôle in the formation of the veins, and fissuring and silicification in that of the replacement deposits.

Veins and Fissure Zones—Veins and fissured zones with quartz as the principal filling are common throughout the area covered by the Bitter Creek argillites and occur occasionally in the grano-diorites and Bear River volcanics, and more frequently in the augite porphyrite areas, especially the one at the head of Glacier creek. The strike of the veins in the argillites is usually northerly or northwesterly, roughly parallel to the edge of the granitic batholith on the west and the dips are westerly or towards it. In the massive rocks, the strikes are more variable, occasionally trending east and west.

The quartz veins occur singly, and in groups following shear zones. The principal zone in the argillites is that on which the Portland Canal mine is situated and may be called the Portland Canal fissure zone. This is clearly traceable from the Jumbo

and Ben Bolt claims situated near the head of the South Fork of Glacier creek northwesterly to the Portland Canal mine, a distance of over 2 miles. Beyond this point, the surface drops down into the deep valley of Glacier creek and exposures for some distance are infrequent. Occasional quartz outcrops, however, occur at intervals in the same strike and there is little doubt that the zone continues across the valley. North of the valley, the outcrops increase in number and the zone is easily traceable through a number of properties to the Sunbeam claim, a total distance from the Jumbo of over 4 miles.

The zone varies greatly in width and general character along its course. At the Jumbo it consists of a mass of crushed and brecciated slates over a hundred feet in width, silicified in places, and enclosing numerous small quartz stringers and kidneys but no large persistent quartz vein. Farther to the north in the steep slopes rising up from the south fork of Glacier creek, the quartz occurs mostly in a central band usually from 6 to 20 feet in width, bordered on both sides by crushed and partially silicified slates. Descending into the deep valley of Glacier creek, quartz outcrops occur over a width of fully 800 feet. The country here is mostly concealed and the veins have not been traced out. At the Stewart mine half a mile north of Glacier creek, the zone has a width of 400 feet and contains four main quartz veins, the largest 27 feet wide. At the Sunbeam claim near its northern termination, only one large vein is exposed.

While the general zone of fissuring and silicification appears to be continuous from the Jumbo to the Sunbeam, and is marked throughout its course by quartz croppings, the individual quartz leads contained in it have a more limited range. They die out when traced along the zone and are replaced by others at a different horizon. Some of them have considerable persistence, being traceable through several claims, while others are quite short.

The metallic minerals in the zone consist of pyrite, galena, and blende with occasionally a little chalcopyrite, and in places, some native silver. Concentrations of these minerals into ore bodies of various sizes occur at a number of points along the zone and are described in connexion with the mines.

Quartz veins, some of large size, occur in the argillites south of the Bromley glacier and smaller ones in other parts of the district, but so far no important ore bodies have been found in them.

The veins in the Bear River volcanics in the argillaceous bands associated with them and in the augite porphyrite areas, are smaller as a rule than those in the main argillite area. Quartz is the principal gangue, but in places, calcite, and less commonly barite and siderite, are present in considerable quantities.

Some of the veins cutting the augite porphyry area on the Middle Fork of Glacier creek, contain small ore-shoots running high in silver. The metallic minerals present are argentiferous galena, pyrite, tetrahedrite, tennantite, and blende. A considerable amount of exploratory work was done on these veins in 1910 and some high grade silver ore was mined and shipped, but the shoots encountered proved to have little persistence.

Free gold is reported from some of the quartz veins of the district; none was seen by the writer, and if present, its distribution must be very limited.

Replacement Deposits.—In the massive and slightly schistose greenstones of the Bear River formation, the ore deposits occur characteristically in irregular, often ill-defined masses. A number of red patches, due to the oxidation of these masses, are plainly visible from the valley in the bare slopes of Bear River ridge, in the mountains bordering upper Bear river and in those lying between Bear river and American creek. The shapes are very variable, some are wide and blunt, others rounded or elliptical, and a few are elongated, resembling wide irregular veins. In some of their features these mineralized areas resemble contact metamorphic deposits, but the characteristic contact metamorphic minerals, such as garnet, epidote, augite, etc., which accompany such deposits, are never present in quantity, and are usually altogether absent. Garnet, mostly in disseminated crystals, was seen at only two of the croppings visited.

The gangue in these deposits is mostly the more or less altered country rock, although some quartz is usually present, and in places there is a considerable development of this mineral. Calcite and barite also occur, but are less common.

The deposits probably always occur in connexion with lines of fissuring, or, as suggested by their irregular outlines, with broken areas, but this is not always evident. In some of them the relationship is plain, as they are bounded on one, or sometimes on both sides by fissures, and for portions of their courses, especially where the replacement is nearly complete, resemble and practically are veins. Traced farther, the space between the so-called walls becomes less well mineralized and often passes into ordinary country rock. Transitions occur from this vein like type, through occurrences partially bounded by walls, to others wholly lacking in definite boundaries other than those afforded by the gradual disappearance of the replacing minerals. They are often of large size occasionally a hundred feet or more across.

The metallic minerals in the replacement deposits are generally similar to those in the veins, except that pyrrhotite is occasionally present in place of pyrite. The proportion of chalcopy-

rite is probably greater on the whole, and the proportion of galena less.

Pyrite, often carrying significant gold values, is usually the principal mineral present. The pyrrhotite is always, as far as known, low grade. The associated minerals are chalcopyrite and galena in varying quantities, and usually a little blende. The chalcopyrite at the Redcliff ore body, the only member of this class of deposits on which much development work has been done, is distributed in grains, bunches, and interbanded with pyrite through the whole mass of the lode, and forms a considerable percentage of it. In most of the occurrences examined the copper and lead sulphides are present only in portions of the pyritized area, and in some are apparently absent altogether.

A large number of the deposits of this class have been roughly prospected, mostly with surface cuts, cross trenches, or short tunnels but so far with little success. A body of commercial ore has been developed on the Redcliff and a few others examined are worth further exploration, but in most cases the quantities of the valuable minerals present have proved too small and their distribution too bunchy and erratic for successful exploitation.

MINERALOGY.

ORE MINERALS.

Gold.—While no specimens containing free gold were collected by the writer, it is reported, on good grounds, to occur in a quartz vein crossing the Ruby claim now being developed by the Portland Bear River Mining Company. The vein in places assays high in gold. Free gold is also stated to occur in a yellowish quartz vein, from 4 feet to 10 feet in width, on Gold Bar No. 1 claim, south of Bitter creek.

Native Silver.—Native silver in rounded blebs and in plates often with crystalline surfaces, enclosed in quartz, and in thin flakes and scales along partings, occurs in places in the workings of the Portland Canal Mining Company, the Stewart Mining and Development Company, on the O. K. claim, and in other places. There is reason to believe that the silver is, partly at least, an original constituent of the ores. It often occurs in solid quartz, associated with iron and other sulphides which have undergone no change of any kind.

Iron Pyrite.—This is the most abundant mineral in the district. It occurs in some quantity, and is usually the principal mineral present in all the showings, both in the argillites and greenstones. It also occurs in grains disseminated through most of the rocks of the district. Its gold content is often important,

and in places high assays for gold have been obtained from it. The silver tenor is also important in some showings.

Pyrite from the Portland Canal mine usually carried about 0·30 ounces per ton in gold and from 13 ounces to 20 ounces in silver. Specimens from the Montrose showing owned by the Redcliff Mining Company are reported to have assayed over 5 ounces per ton in gold.

PYRRHOTITE.—Pyrrhotite occurs in veins and large irregular masses in the Bear River greenstones, but is seldom found in veins cutting the argillites. Its tenor in gold is usually low.

ARSENOPYRITE.—Arsenical pyrites occurs in some of the veins, but is not common.

CHALCOPYRITE.—This mineral is widely distributed in the district, and at the Redcliff mine constitutes a considerable proportion of the lode. It occurs in veins and lenses in the Bear River greenstones, in veins in the granite, and occasionally in veins cutting the argillites. Except at the Redcliff no large body has so far been found.

BORNITE.—Bornite is reported to occur on the Rangoon, a claim not examined by the writer.

TETRAHEDRITE.—This rich silver mineral, commonly known as grey copper, occurs in grains, bunches, and small lenses, in some of the veins cutting the augite porphyrite area at the head of Glacier creek.

TENNANTITE.—This mineral is reported by Mr. W. F. Ferrier from a vein crossing the Columbia and Evening Sun claims on the Middle Fork of Glacier creek.

GALENA.—Lead sulphide is one of the important minerals of the district. It is found in some quantity in most of the deposits, its usual associates being pyrite, zinc blende, and occasionally chalcopyrite. Veins or narrow lenses of nearly solid galena, a few inches in thickness, occur in the Bonanza, Independence, and a number of other claims. Most of these appear to be short.

The galena, besides its lead content, always holds appreciable values in silver. The tenor is variable, ranging from a few ounces to over 100 ounces per ton.

SPHALERITE.—Zinc blende is widely distributed in the district, accompanying iron pyrite and galena. The percentage present is usually small, but in some instances, notably on the Ajax, is considerable. The discovery of workable zinc deposits is not improbable.

STIBNITE.—This mineral is not common. Specimens were obtained from the Silver King claim and it is also reported to occur in the Mountain Boy.

ARGENTITE.—Argentite is reported to occur at a number of points, but was not positively identified. Specimens shown as

argentite proved on examination to be thin plates of tarnished native silver.

ANTHRAXOLITE.—This dark carbonaceous mineral occurs in small quantities in a quartz vein on Bitter creek, and also on a claim in the Salmon River district.

GANGUE MINERALS.

QUARTZ.—Quartz is the common gangue mineral of the district, and in the slates is often the only one present. It occurs in numerous veins in all the formations of the district, and also, though less prominently, in the irregular replacement deposits characteristic of the Bear River formation. Large areas of country rock have also been silicified and altered into cherts.

In veins the quartz filling is often marked by long lines of interlocking crystals, and in places a concentric arrangement of the crystals around fragments of country rock, and occasionally around metallic grains, is a prominent feature.

CALCITE.—Coarse crystalline calcite occurs in some quantity in most of the deposits, and in a few of the smaller veins is the principal vein filling.

SIDERITE.—Siderite is not common as a gangue mineral, but occurs as the principal filling in a vein traversing the Silver King and Evening Sun claims on the Middle fork of Glacier creek.

BARITE.—Veins of nearly pure barite a few inches in width occur on the Waratah claim, high up on the slopes of Mount Dolly. It also occurs as a gangue mineral in the Mountain Boy lode on American creek, and in other showings in the vicinity.

GARNET.—Garnet is rare in the camp, occurring, so far as known, only in small quantities on two claims, both in the Bear River greenstones.

CHLORITE.—A bright green chloritic mineral is a conspicuous constituent of the veins on the George E, O. K., and other claims north of Glacier creek. It occurs in blotches and narrow bands up to half an inch in width, following lines of quartz crystals. The bands are occasionally straight for short distances, but usually follow wavy courses, and in many cases circle round fragments of slate and other impurities enclosed in the quartz vein filling.

This mineral is usually spoken of in the camp as a silver chloride, but is referred by Mr. R. A. A. Johnston, who examined a number of typical specimens collected by the writer, to the chlorite group. It appears to be an original constituent of the veins.

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Chlorite, sericite, and other micaceous minerals occur largely as alteration products in the replacement deposits of the Bear River greenstones.

CIMOLITE.—A whitish clay-like mineral occurring in small quantities in fissures in the Jumbo mine has been identified by Mr. R. A. A. Johnston as cimolite.

HORNBLENDE.—Secondary hornblende occurs in a few places in the deposits in the Bear River greenstone, but is not prominent.

MINING PROGRESS.

The boom years of 1909 and 1910 in the Portland Canal district, when any prospect no matter how small commanded a price, has been followed by the inevitable reaction and during the past season work was in progress on only a few of the numerous properties in the camp. The wide-spread character of the mineralization of the district, and the numerous ore croppings encountered everywhere, raised hopes which have only been very partially realized. As development work advanced it became evident, that in the majority of cases the deposits were either too low grade or the valuable minerals were concentrated in too small bunches and lenses to be successfully worked. In a few instances, especially along the Portland Canal fissure zone, ore bodies of considerable size and persistence have been opened up and steady development has been carried on with fairly satisfactory but still not conclusive results. The ore bodies enclosed in a wide shear zone are difficult to follow, and as the grade of the ore is not high the cost of finding and following them has proved a more serious handicap than was anticipated.

The future of the camp does not, of course, depend entirely on these as in the slump, work has largely stopped not only on the poorer prospects, but on some having fair chances of success, and numerous showings have not been explored in any way. It will be difficult, however, to interest capital in their development until one or more of the prospects now being operated proves able to yield returns on the amounts already expended.

During the season considerable work was in progress at several points on the long Portland Canal fissure zone, principally by the Pacific Coast Exploration Company on the Jumbo and Ben Bolt; the Portland Canal Mining Campany on the Lucky Seven and Little Joe, and the Stewart Mining Company on the George E. The Portland Canal mine has reached the producing stage, and the shipments of concentrates aggregating over 1,000 tons have already been made. The other mines were engaged in exploratory work. Development work was also

continued on the Redcliff mine, on the Ruby claim, and some desultory prospecting was done at various points in the district.

MAIN FEATURES OF SOME OF THE PRINCIPAL MINES AND PROSPECTS.

CLAIMS ALONG THE PORTLAND CANAL FISSURE ZONE.

Portland Canal Mining Company.

This Company under the efficient management of Mr. W. J. Elmendorf, M.E., has been engaged for some years in developing a group of claims on Glacier creek, and during the past season a considerable tonnage of ore was extracted, concentrated, and shipped.

SITUATION.—The Lucky Seven and Little Joe, the two claims most developed, are situated south of Glacier creek about 2 miles east of Bear river. The country slopes steeply up from Bear river and Glacier creek, and at the workings (lower tunnel) has an elevation of 2,410 feet above sea-level.

GEOLOGY.—The Glacier Creek basin is occupied principally by the dark coloured Bitter Creek argillites, described on a previous page. Near the mouth of the creek they are replaced by the Bear River greenstones, and between the South and North forks are intruded by a large augite porphyrite stock. The argillites are seldom contorted or crumpled except in the vicinity of the vein, and have a fairly regular westerly dip. The general strike is a few degrees west of north. They are traversed by a number of large diorite porphyry dykes. These follow generally the dip and strike of the argillites but occasionally cut across the bedding planes at a low angle.

VEIN.—The vein explored forms part of the long Portland Canal fissure zone. At the workings the fissured zone has a width in places of over 30 feet. It is irregularly silicified, and consists of quartz often filled with metallic sulphides and usually holding fragments of slate, alternating with partially silicified and unaltered slates, and brecciated slates cemented by quartz. Often there is a persistent central quartz mass from 2 to 6 feet in width, bordered on both sides by small quartz lenses and veinlets which diminish in size and frequency outwards. The boundaries are occasionally definite walls, but similar walls often occur in the interior of the vein, and simply mark subordinate lines of fissuring. Ordinarily the limits are known only by the disappearance of the quartz. Following the strike the proportion of quartz in the vein varies greatly. The amount

present is doubtless a measure of the completeness of the fissuring and shattering suffered by the slates in any particular part and the relative ease with which they were infiltrated and replaced by the ore-bearing solutions.

The dip of the vein is westerly, and is comparatively low, somewhat less than 30°. The strike is about 25° west of north. Both dip and strike conform closely to that of the enclosing argillites.

WORKINGS.—The fissure zone where it crosses the property operated by this Company outcrops on the hillside sloping down to Glacier creek, and is opened up by three main tunnels known as Nos. 1, 2, and 3 at elevations of 2,505·06 feet, 2,464·47 feet, and 2,410·46 feet respectively.

The upper or No. 1 tunnel has a length of 190 feet. It follows a practically continuous ore body for a distance of 100 feet, beyond which the sulphides which carry the values occur in a condition too disseminated to constitute commercial ore. An altered and silicified diorite dyke occurs at the breast.

No. 2 tunnel is situated 110 feet westerly along the vein from No. 1 and has a length measured along its curving course of 480 feet. An ore body was reached at 60 feet and followed for 160 feet, beyond which the drift reaches and follows a diorite dyke for 100 feet. A second important ore body was then found practically resting on the dyke, which continued for 120 feet. This ore body extends downwards along the dip towards No. 3 level and has been partially stoped out, but so far has not been found on that level. It also probably continues upward to the surface, as cuts in the fissure zone in the direction in which it ought to outcrop show similar ore.

No. 3, the lowest tunnel 170 feet northwesterly along the vein from No. 2, is much the longest of the three but shows the least ore. Owing to the contour of the surface the vein outcrops considerably north of the probable extension downwards of the ore bodies found in the upper level. It has a length following its winding course of over 750 feet. Ore was encountered at 410 feet and followed for 60 feet, then either pinched or was lost. Some ore was also found in a short cross-cut to the left 150 feet from the portal and in a second cross-cut to the right 120 feet farther in. The extent of these ore bodies is not known.

In addition to the three main tunnels, the workings include a number of exploratory cross-cuts, and drifts, and several raises connecting the three levels.

ORES.—The Portland Canal ores consist mainly of auriferous pyrite associated with varying but much smaller quantities of silver bearing galena, and zinc blende, and in portions of the vein a little native silver most of which appears to be primary. The galena at times is interbanded with the pyrite but as a rule is

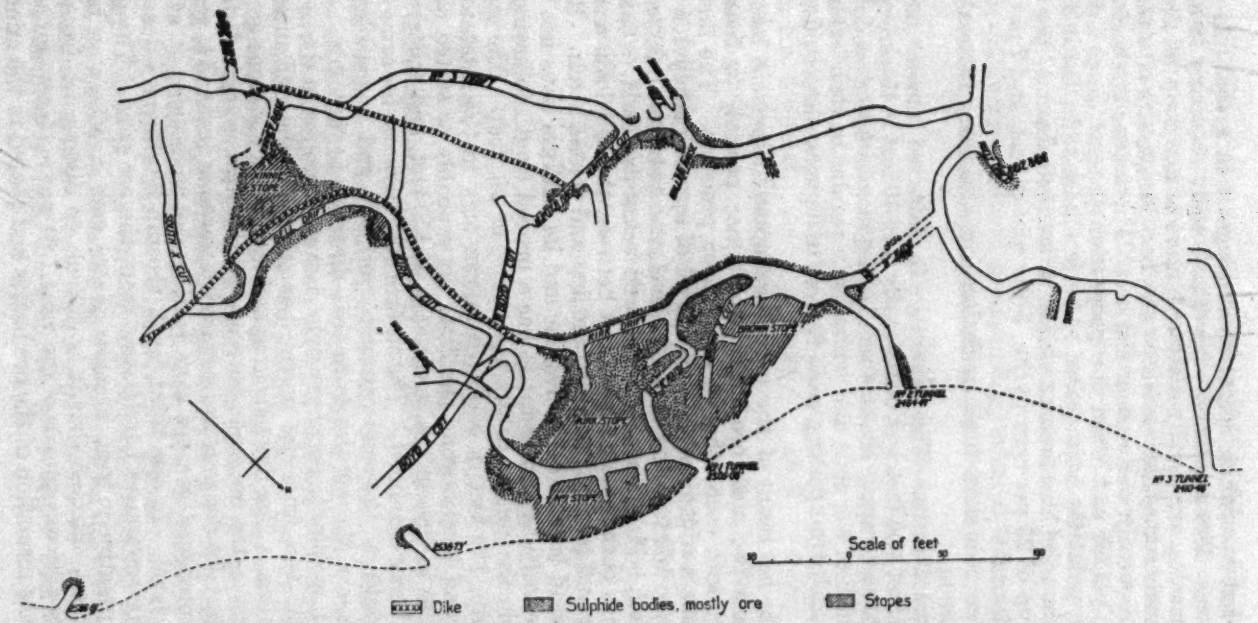

FIG. 1.—Plan of workings of Portland Canal mine, from surveys by management, August, 1911.

scattered somewhat irregularly through it in grains and small bunches. The sulphides, while occasionally occurring in almost solid masses, are usually scattered, more or less densely, through a siliceous sometimes a slaty matrix. Fragments of slates are also frequently enclosed in the ore. The values are mainly in the sulphides and when the proportion present drops below a certain point the vein ceases to be profitable. In the ordinary ores, the sulphides present usually amount to about 37 per cent, made up of 25 per cent pyrite, 5 per cent galena, and 7 per cent zinc blende.

The ores show little oxidation and secondary minerals are uncommon.

Ore Bodies.—The ore occurs in flattened masses usually from 2 feet to 6 feet, but occasionally 8 to 10 feet in thickness and probably averaging about 4 feet. The masses never occupy the full width of the zone and while fairly regular in their extension occasionally jump along cross fissures to higher or lower positions in it.

The net result of the operations up to the present has been to expose two main ore bodies which may possibly be found to connect with each other as exploration proceeds. The first ore body has a width on the upper level of approximately 100 feet, widens to 160 feet on the second level, and narrows to 60 feet on the third. It has not been followed below this level. This ore body has been mostly stoped out between the first level and the surface and partially between the first and second levels. Below the second level it is less regular and its outlines have not been satisfactorily determined. It has a proved length following the dip from the surface to the lower level of 240 feet. The second ore body, 120 feet in width, is known only in the extension of the second level beyond the first. It probably as stated before continues to the surface, a distance of 150 feet, and this ground is now being examined. The surface cuts show ore for some distance south of the underground workings and a considerable extension of the ore-shoots in that direction is probable.

A large diorite porphyry dyke first encountered in the second level 230 feet from the portal, has added to the difficulties of exploration. The dyke striking and dipping in the same general direction as the ore zone, outcrops on the surface some distance below it. Its dip near the surface is somewhat less and it gradually approached the ore zone joining and underlying it at the second level. In the third level, the dip has increased and it probably soon after bends away from the ore zone. The dyke is comparatively fresh in some places and in others so badly altered and silicified that it is difficult to distinguish from the ordinary siliceous gangue of the mine. It was evidently intruded before the formation of the ore bodies and shared in the mineral-

ization. Similar dykes are common in the neighbourhood and throughout the district and its presence in the ore zone does not appear to have any special significance.

VALUES.—The mine has been well sampled by the management and the values are fairly well known. They are in gold, silver, and lead, and usually aggregate from $11 to $12 per ton. The gold usually varies from 0·12 to 0·30 ounce, the silver from 5 to 25 ounces, and the lead from 3 per cent to 12 per cent per ton.

The following results of the sampling, selected from a large number of assays, are fairly typical of the general run of the ore:—

	Gold.	Silver.	Lead.
Face of No. 2 tunnel. Sept. 4, width 5 feet	0·16 oz.	6·6 oz.	13 per cent.
Slope in No. 2 tunnel, width 6 feet.	0·16	9·00	6
Face on No. 3 tunnel	0·24	15·2	3·9
A sample of waste from No. 2 tunnel gave	0·02	1·46	Nil.

The following assays by Mr. J. H. Marston, assayer for the Company, are interesting as showing the tenor of the different sulphides in the previous metals. The material used was as pure as could be obtained.

	Gold.	Silver.
Blende	0·10 oz.	5·20 oz.
"	0·10	3·00
Pyrite	0·30	13·50
"	0·30	20·00
Galena	0·10	85·00

EQUIPMENT.—The equipment of the Portland Canal mine includes an aerial tramway over a mile and a half long from the mine to the flat bordering Bear river, a mill for concentrating the ores and separating the sulphides, and a power plant. Glacier creek near by furnishes an excellent water-power for the greater portion of the year, and this is used to operate the mill and also for the compressor and electric lighting plants.

The following description of the mine equipment was kindly furnished by Mr. W. J. Elmendorf, engineer and general manager. Since it was written, the nominal capacity of the mill has been increased from 50 tons to 75 tons per day, and some improvements made. These include an improved system of water classification and the addition of a larger Sturtevant

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crusher and six Wilfley tables. In the latter part of the season the mill was running at its full capacity and giving excellent results.

"The concentrating mill of the Company is located at Glacier creek, about 3½ miles north from Stewart. The mine is reached by a trail about 3 miles in length from that point, and is about 2,250 feet above tide-water.

"Water-power for the operation of the mill and air compressing plant is taken from Glacier creek by a flume 3 feet by 4 feet inside measurement and about 1,100 feet in length. Water rights to the amount of 2,000 miners inches are held by the Company.

"The concentrating mill is advantageously located on a hill-side millsite, and has a nominal capacity of 50 tons daily. The crushing machinery consists of a Sturtevant crusher, 2 pairs of Allis-Chalmers rolls and a slow speed Lane Chilean mill. The concentrating machinery includes four 4-compartment Abeling jigs, 1 each Wilfley and Overstrom tables, and 2 suspended type Allis-Chalmers 6 foot vanners. Settling tanks are provided for the slimes. The sizing is done by three trommels of the new sprocket driven type, and a very complete system of hydraulic classifiers. Especial attention is paid to the careful sizing of the ore.

"A short conveyer belt carries the ore from the crusher to the storage bin, which in turn feeds the first set of rolls by means of a revolving feeder.

"The ore is supplied to the mill by a covered chute, and this, with the two ore bins in the mill, furnishes a storage capacity of about 400 tons.

"Power is supplied by a 6 foot and 3 foot Pelton wheel working under a head of 100 feet. The larger wheel can be used to drive all the mill machinery, but the smaller can be connected with the jigs and tables in order to ensure constant speed for these machines. Its principal use is to drive the generator for the electric lighting of all the buildings.

"The conveying, crushing, and screening machines are ample for a mill of double the present capacity, and were installed with the contingency of an increase in the concentrating machines in view. Just what these will be, and in what number, will be determined by the behaviour of the present installation.

"Large bins for the concentrates are provided, and these fill from pipes and launders, thus avoiding the handling of any of the mill products, the middlings and tailings also being distributed automatically.

"The aerial tramway which connects the mine with the mill is of the Bleichert type, and was made by the Trenton Iron Works. It is 1¾ miles in length, and of a 17 per cent grade. About 900 pounds of ore can be loaded into each bucket, of which there are 26. A round trip is made in a little less than an hour, and the power for operation is furnished by gravity alone, the loaded buckets on one side bringing the empties and whatever mine supplies may be needed up on the other.

"The air compressor is a D–2 type Canadian Rand compound machine of 520 cubic feet free air per minute capacity. This is installed at the mill, and is direct driven by a 6 foot Pelton wheel. The air is conveyed to the mine by a 4-inch pipe line.

"An office, assay-office, and boarding house have recently been completed at a cost of about $7,000. These buildings are commodious and comfortable, a bath and many other conveniences being included in the men's quarters."

Jumbo and Ben Bolt.

The Jumbo and Ben Bolt are being opened up by the Pacific Coast Exploration Company under the direction of Mr. Curran. They are situated south of Glacier creek 4 miles from Bear river, following the valley of Glacier creek and at an elevation of about 2,500 feet above sea-level. A trail from Bear river up Glacier creek and its south branch has been built to the mine.

The claims are staked on the southern end of the exposed portion of the Portland Canal fissure zone, its further course if any to the southeast being concealed by drift. The zone at

this point while traversing the Bitter Creek argillites, skirts closely the southern edge of an area of massive augite porphyrite and is intruded by apophyses from it.

The fissure zone in the Jumbo and Ben Bolt claims is exposed in a series of conspicuous silicified slate cliffs stained with iron traceable for fully 2,000 feet. The width of the zone is not exactly known but must in places exceed 100 feet. It is made up of silicified, brecciated, and crushed slates holding numerous small stringers and lenses of quartz, but contains no large persistent quartz vein, such as crosses the Chicago claim on the same zone farther to the north.

The dip is to the west at an angle of about 30° and the silicified zone has been explored at four points in a distance of 870 feet by cross-cuts starting in the exposed eastern face and driven into it for varying distances.

The principal workings are at what is known as No. 1 or the shaft cross-cut. At this point, a zone of good ore about 5 feet thick is exposed at the surface. This has been followed by a drift in a southeasterly direction for a distance of 165 feet. The ore-shoot is continuous along the first 80 feet, beyond which the sulphides occur only in scattered grains.

Other workings here consist of a shaft about 25 feet deep, sunk at the portal of the drift, and a short cross-cut to the west from it to reach the extension of the ore-shoot exposed in the upper level. This was soon encountered, and at a distance of 38 feet from the foot of the shaft drifts have been run along it in both directions. The drift to the northwest exposes ore for a distance of 85 feet and the one to the southeast for 20 feet. Both drifts have been continued beyond the ore into waste. The ore-shoot is poorly defined and difficult to follow and the workings are as yet insufficient to show whether its limits are reached in the drifts or a change in the direction of the shoot carries it away from them.

The ore-shoot exposed in the workings has a minimum length of 105 feet and a proved extension along its dip of 50 feet. It has not been followed below the drifts from No. 1 cross-cut. Its width is variable ranging from a few inches to 10 feet or more. It consists of iron pyrite, with smaller quantities of galena, sphalerite, and occasionally some chalcopyrite, scattered more or less densely in grains and bunches through a gangue of quartz or crushed and silicified slate. The limits of the ore zone are not marked by fissures and are defined only by a gradual, in places somewhat abrupt diminution in the quantity of sulphides present. A diorite porphyry dyke follows the ore in the upper level, and a similar probably the same dyke, is cut into in the lower level in a short extension of the cross-cut beyond the drifts. The dyke is altered and silicified in places and is referred

to the older pre-mineralization series. The dykes of this series occur at several points in the district either adjoining or close to ore zones, but their genetic connexion if any, is probably limited to shattering the slates and so forming a channel for the ore solutions.

The ore at the Jumbo usually carries values of from $10 to $15 in gold, silver, and lead. The following assays are furnished by the management.

	Gold.	Silver.	Lead.	Cu.	Zn.
Sample 14 feet across shoot No. 1 cross-cut	0·07 oz	5·64 oz	15·01 %	0·9%	3·16 %
Average No. 1 tunnel	0·08 oz.	5·90 oz.	11·50 %	——	4·70 %
Average No. 3 tunnel	0·06 oz.	5·77 oz.	15·50 %	0·11%	8·5 %

No. 2 cross-cut, situated 265 feet northwesterly along the fissure zone from No. 1, has been driven in for a distance of 120 feet without encountering any considerable body of ore. It starts above the base of the zone and an ore horizon may still be found in the lower unexplored portion. No. 3 cross-cut, 223 feet northwesterly from No. 2, penetrates 99 feet of silicified slates, then a wide diorite porphyry dyke dipping to the west, beyond which there is a small development of ore not yet followed up. No. 4 cross-cut is situated 330 feet in a southeasterly direction from No. 1, and when visited, was in 50 feet without reaching ore.

The workings of the Jumbo and Ben Bolt have been planned on the assumption that the ore body encountered in No. 1 cross-cut, continues north and south along the silicified zone which crosses the claims. While it cannot be said that this view is entirely disproved by the negative results of the still incomplete work on the exploratory cross-cuts, it is more likely that ore will be found in separate shoots along the zone and probably at different horizons in it.

Chicago Nos. 1 and 2.

These claims are situated north of the Jumbo and Ben Bolt on the same fissure zone. The zone is more contracted, exposures at intervals showing a quartz lead with included slate from 10 to 20 feet in thickness. Very little exploratory work has been done on the claims. An ore body outcrops on Chicago No. 2 and the extent of this is now being investigated.

Gipsy.

This claim is in the group owned by the Portland Canal Mining Company, and is situated immediately north of the Little Joe, the claim on which most of the development work has

been done. It contains a vein about 3 feet in width, which is supposed to be a branch from the main zone of mineralization, but has not been actually traced into it. Its direction is nearly east and west, and the dip is southerly at an angle of 60°.

The Gipsy lead, while narrow, is traceable for several hundred feet, and carries good values in places at least. The ore, mostly pyrite, galena, and blende in a quartz matrix, taken from a shallow shaft sunk on the vein, is reported to assay over an ounce in gold and 10 ounces in silver per ton.

O. K. Fraction.

This claim is situated north of Glacier creek. The fissure zone on it contains two quartz veins about 60 feet apart and quartz stringers occur in the country between. The main vein strikes 10° east of north, and dips to the west at angles of from 45° to 70°. In places it is a well-defined quartz vein from 2 feet to 6 feet in width, while in others the quartz is intermixed with considerable slate.

The workings, which consist of a tunnel driven along or near the lead for a distance of over 150 feet, show little commercial ore. Native silver occurs in the croppings of the vein at several points.

During the past season a small ore-shoot was opened up by surface cuts in the north wall of Glacier Creek canyon.

Little Wonder.

This claim adjoins the O. K. Fraction on the east, and is being explored by the Portland Wonder Mining Company. The fissured zone from the O. K. passes into and crosses it. The workings consist of a shaft, a cross-cut tunnel 150 feet in length to the lead, and a drift of 150 feet along it. Some sulphide ore carrying good values occurs in the shaft, and bunches were also encountered in the drift. The mine was idle during the season.

Glacier Creek Mining Company.

North of the O. K. and east of the Little Wonder is the Lulu claim owned by the Glacier Creek Mining Company. Veins outcrop at several points in the sides of a canyon which crosses the claim. These have been explored by short tunnels. Sulphide ore very similar to that at the Portland Canal mine is exposed in two of these but so far has not been found in quantity.

Stewart Mining and Development Company.

This Company owns a group of claims north of those held by the Glacier Creek Mining Company. A large amount of exploratory work has been done on the George E., one of the claims in the group, and several of the others have been prospected by surface cuts.

The argillites in the vicinity of the lead are much disturbed and dip steeply to the west. They are traversed by a number of dykes belonging both to the pre-mineralization and the post-mineralization series. In crossing the former the leads become restricted, and at times are represented only by stringers of quartz.

The fissured and crushed zone on the George E. has a width of over 350 feet, and includes four well-defined and nearly parallel quartz leads,one on the western and the other three on the eastern side of a deep narrow canyon which crosses the claim. The workings east of the canyon consist of a cross-cut tunnel to the east, which cuts the three leads known as Nos. 1, 2, and 3 veins, at distances of 50 feet, 140 feet, and 300 feet, and drifts along the leads of 60 feet, 120 feet, and 200 feet respectively.

The veins have a general direction of N. 12° E. and dip to the west at angles varying from 40° on the western or No. 4 vein to 80° in the eastern or No. 3 vein. Nos. 1 and 2 veins have dips of 55° and 45° respectively.

The eastern or No. 3 vein is the largest of the group, having a width in the tunnel of 27 feet. On the surface 200 feet above its width is reduced to 7 feet. It consists of quartz, sometimes nearly pure but usually holding fragments of or alternating with the broken, argillaceous country rock. Some calcite is also present. No. 1 vein has a width of about 4 feet; No. 2 of 6 feet.

The portions of the vein explored are all lightly mineralized, mostly with iron pyrite in grains and bunches, occasionally a little galena, some blende, and native silver. Specimens often yield high assays in silver and gold, but in general samples the values are low, seldom much exceeding $4 per ton.

No. 4 vein west of the canyon was explored during the past season by a drift following the lead, 570 feet in length.

A diorite dyke overlies the vein or line of fissuring on the west, dipping and striking in the same general direction.

Ore occurs at the mouth of the tunnel and was again encountered in a short cross-cut to the west 120 feet from the portal. The ore here has a width on the tunnel level of 14 inches, but widens to 3 feet at the bottom of a winze 50 feet long sunk on it. It directly underlies the dyke, both dipping to the west at an angle of 48°. The ore-shoot appears to curve across the drift a few feet beyond the winze, and little ore occurs along the

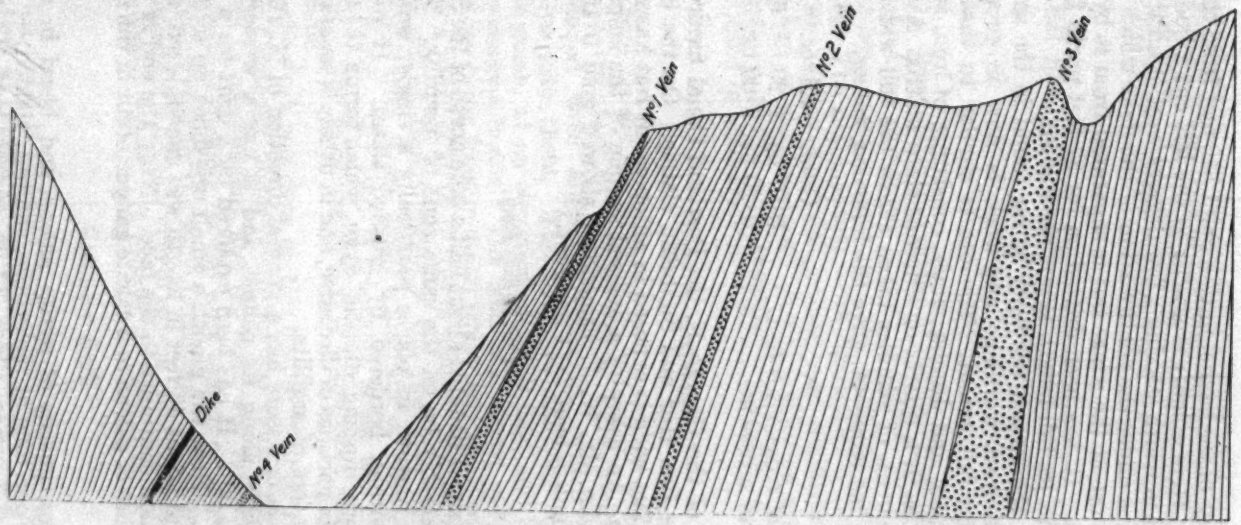

FIG. 2.—Diagrammatic cross-section of Portland Canal fissure zone at the Stewart mine

further course of the tunnel until a point 540 feet from the portal is reached. Here a short cross-cut to the left cut a body of ore nearly 6 feet in width striking a few degrees west of north. This ore-shoot dips under the continuation of the dyke which directly overlies the ore at the winze but is separated from it by 15 feet of argillites. It has been drifted on for 37 feet north from the cross-cut, but its full length is not yet known.

This is the largest ore body so far found in the somewhat extensive Stewart workings and work is now in progress to determine its full extent. The ore is similar to that at the Portland Canal and Jumbo mines, consisting of iron, lead, and zinc sulphides in a quartz or siliceous slate matrix. Assays, by the management, of samples taken across the full width of the shoot along the cross-cut, gave the following values.

	Gold.	Silver.	Lead.
South side of cross-cut 6 feet.....	0·07 oz.	4·20 oz.	6·12%
North side of cross-cut.....	0·20 oz.	2·00 oz.	3·25%

North of the George E. the Portland Canal fissure passes through the Ben Hur and Sunbeam claims. On the latter an ore body 4 feet wide is exposed in an open-cut but has not been followed up. An assay of a general sample of the sulphide ore obtained from Mr. W. J. Elmendorf showed gold 0·20 ounce, silver 5·8 ounce, lead 7·41 per cent.

The Main Reef.

This claim is situated about half a mile north of the Sunbeam and may possibly be on the same zone of fissuring. The vein explored is narrow, in places practically a single, well-defined line of fissuring, bordered by crushed slates. It overlies a large, westerly dipping dioritic dyke, which forms the foot-wall of the vein in portions of its course, and in others is separated from it by a few feet of argillite.

The vein or fissure has a general direction of N. 10° E. but curves slightly along its course, and it has a westerly dip of from 30° to 50°. It has been explored by a drift for a distance of 240 feet. Near the mouth a small ore-shoot up to 30 inches in width and about 40 feet in length was encountered, and light mineralization continues to the face. Near the end of the drift small bunches of galena in a calcite gangue occur in the fractured slates.

The ore consists of pyrite, galena, and blend in a calcite gangue. Four tons of picked ore, shipped, yielded:—

Gold, 0·7 ounce; silver, 20·94 ounces; lead, 23 per cent.

Several other showings on the claims have been prospected, one situated at the base of the same large dyke which underlies the main lead. This consists of 4 to 5 feet of silicified slates, mineralized with pyrite, blende, and some galena and chalcopyrite.

OTHER SHOWINGS IN THE VICINITY OF GLACIER CREEK.

Tyee.

The Tyee is situated on the Main Reef trail from Bear river at an elevation of 300 feet above the valley. The argillites here are cut by a granitic stock, and the showing occurs in fractured granite. The development work consists of a shaft, filled with water at the time of my visit, and an open-cut 40 feet to the north. Three feet of shattered and partially silicified granite, holding considerable pyrite and occasional bunches of chalcopyrite, are exposed in the cut.

Silver Bow Group.

These claims are situated on the upper waters of Maude gulch, a tributary of Glacier creek. The argillites here are interbanded with altered greenstones, which are probably intrusive into them. The principal showing seen occurs in Maude gulch, at an elevation of 2,850 feet, and follows one of the greenstone bands. The lead is a strong one, the massive greenstone being fractured and irregularly silicified and mineralized for a width of 10 to 15 feet in places. Pyrite in small lenses, bands, and scattered grains is the principal mineral present. Associated with it are small quantities of blende, galena, and tetrahedrite. The lead is traceable along the creek for fully 700 feet. The workings consist of a couple of shafts, and some open-cuts.

Some work was done on this lead in 1910 by the Silver Bow Mining Company under bond, but the values obtained did not come up to expectations, and the bond was thrown up.

A galena showing on the west branch of Maude gulch was also investigated by the same Company. It occurs in argillites, and consists of a narrow vein of galena and blende, about 6 inches thick, where widest. It proved to have little persistence.

Northern Belle.

This claim is situated west of the glacier from which the North fork of Glacier creek issues, at an elevation of 3,175 feet.

Only a little stripping has been done. This exposes an oxidized zone 5 to 6 feet in width, made up of quartz and slate, and mineralized with pyrite and smaller quantities of chalcopyrite. The latter often occurs in small solid masses several inches across. The lead has an east-west strike, and dips to the south at an angle of 40°. It is exposed for a distance of 50 feet.

Lakeview.

The Lakeview was examined by Mr. Hayes. It is situated on the hillside sloping down towards Glacier creek about a mile east of the Stewart mine. The Bitter Creek argillites at this point are cut by a small gabbro stock. The argillites near the stock are altered and broken and in places veined. The principal showing consists of a crushed zone partially silicified about 4 feet wide, traceable for 300 feet. A shaft has been sunk on the lead to a depth of 40 feet. This exposes some irregularly distributed ore made up of pyrite, galena, chalcopyrite, and blende in a siliceous or slaty matrix. No large body has been traced out.

A discovery of high grade ore was reported from this claim late last season, but was not examined.

CLAIMS IN AUGITE PORPHYRITE AREA AT THE HEAD OF GLACIER CREEK.

Columbia and Evening Sun.

These two claims, one south and the other north of the Middle fork of Glacier creek, were partially explored in 1910 by the Lordigordy Mining Company. The country rock is a greyish, medium grained massive augite porphyrite. A vein, usually narrow, but sometimes 6 feet to 8 feet in width, striking about N. 30° E., occurs in both claims, and is supposed to be continuous, but is concealed where it crosses the creek, and for some distance on either side. The vein is usually rather sparingly mineralized, but contains occasional narrow shoots, up to 8 inches in width, of rich ore made up of fine and coarse-grained galena, running high in silver, tetrahedrite, blende, and pyrite. Some tennantite is also present. Two of these shoots, one on the Columbia at an elevation of 450 feet above the creek, and the other on the Evening Sun at an elevation of 600 feet, were investigated, but proved to have little persistence along the strike. The vein filling consists mostly of siderite and calcspar, usually intermixed with more or less of the crushed and schistose country rock. Small shipments of high grade ore have been made from the claims.

Silver King.

This claim, owned by Andrew Nelson, adjoins the Evening Sun on the northeast, and the vein on the latter has been traced into it for a distance of 300 feet. The vein has been drifted at several points. It is irregularly mineralized, most of it sparingly, but a couple of small shoots of ore are exposed in the workings. The minerals present include galena, blende, stibnite, tetrahedrite, and pyrite. The principal gangue mineral is siderite.

Katherine Claim.

This claim is situated near the glacier at the head of the North fork of Glacier creek, at an elevation of 3,400 feet. It is one of a group held in 1910 by the Rush Portland Mining Company. A vein from 1 to 3 feet in width occurs on the claim, and has been followed by a drift 87 feet in length at the time of my visit. Open-cuts exposed the vein for a further distance of over 100 feet in a southeasterly direction, and it is also traceable from the portal of the drift northwesterly for some distance. The gangue is siliceous, and the metallic minerals present include ordinary and arsenical pyrites, galena, blende, and tetrahedrite. The principal values are in silver.

Ajax.

This claim, situated on the east side of the South fork of Glacier creek about 700 feet above the valley bottom, has been explored under bond by the Pacific Coast Exploration Company. Work was discontinued in August and the bond thrown up.

A zone of fissuring, the fissures striking nearly east and west and dipping to the north, is traceable part way across the claim. The zone contains a number of small ore lenses, but none of commercial size have been discovered. The ore consists mostly of pyrite and zinc blende with some galena. The proportion of zinc blende is more than ordinarily large.

Excelsior.

This claim was visited by Mr. Malloch, who furnishes the following description:—

The Excelsior claim is situated on the spur between the Middle and the South forks of Glacier creek, and the main showings occur within a few hundred feet of the ice field which feeds the glacier descending to the head of the South fork. Two veins occur about 100 feet apart and striking approximately north and south. The eastern vein is about 2 feet in width and is well

mineralized with galena, zinc blende, and subordinate amounts of grey copper in a gangue of siderite. Specimens from the capping are reported to have assayed 300 ounces of silver to the ton. This vein dips at about 65° to the west. The second vein strikes more to the northeast and southwest than the first and the dip is nearly vertical. The maximum width observed was 18 inches. The same minerals are present, but there is rather more zinc blende and less galena. Some shallow pits had been sunk on the veins, but comparatively thick deposits of morainic material would have to be removed before the continuation of the veins for any considerable distance in either direction could be demonstrated. Numerous quartz veins were seen on this claim, striking generally east and west, but except for a few copper stains no indications of economic minerals were observed.

CLAIMS ON BEAR RIVER RIDGE WEST OF BEAR RIVER AND AMERICAN CREEK.

International Portland Mining Company.

This Company owns a group of eight claims situated on Bear River ridge, opposite the mouth of Bitter creek. Three of the claims, the Mammoth, Dundee, and Ben Lomond, were prospected in 1910.

The Mammoth showing, as exposed in an open-cut 400 feet above Bear river, consists of a fissured zone about 18 feet wide, cutting an argillaceous band in the Bear River greenstones. At the south wall of the zone the slates are crushed and decomposed for a width of 3 feet, and mineralized somewhat sparingly with pyrite, galena, and blende. Good values are reported from this portion of the lead near the surface. A tunnel 50 feet lower down the slope follows the same crushed zone for a distance of 40 feet. The same minerals are present, but in smaller quantities.

The Dundee showing is situated some distance north of the Mammoth, at an elevation of 850 feet above Bear river. It occurs in the same argillaceous band as the Mammoth, and consists of the broken country rock, seamed for a width of about 10 feet with small irregular quartz veins. Pyrrhotite, pyrite, blende, and a little galena are present.

The Ben Lomond is situated much higher up the mountain slope, at an elevation of about 2,300 feet above Bear river. The country rock here is the Bear River greenstones altered in places into a light coloured schist. Irregular areas of the greenstones are heavily charged with pyrite, and bright red and yellow patches due to its oxidation are traceable along the

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Crest of Bear River ridge between Goose creek and Lydden creek.

mountain side for over half a mile. Some quartz in bunches and veins occurs in the mineralized areas, and chalcopyrite has also been found in several places, but so far not in commercial quantities. Exploratory work consists only of surface cuts.

Redcliff Mining Company.

The Redcliff Mining Company hold a group of 6 claims and some fractions situated along Lydden creek, a tributary of Bear river. Lydden creek issues from a deep gash in Bear River ridge west of the Forks of Bear river and American creek, then bending southward flows for some distance parallel with Bear river and in the same valley before joining it. The mountain ridge west of the valley rises in steep cliffy slopes at an angle of fully 55° and a number of red oxidized zones and patches are clearly outlined on its bare sides.

The Redcliff claim on which nearly all the development work has been done is situated near the southern end of the tier of claims, and while west of Lydden creek is practically in the Bear River valley and easily accessible.

Rocks.—The country rock is a greenish feldspathic porphyrite crushed in places into a coarse schist and fractured irregularly, the fissures striking in different directions, dipping at practically all angles. Some of them show movement but there is no evidence of extensive faulting. The porphyrite is traversed by occasional dioritic dykes belonging both to the older pre-mineralization and the younger post-mineralization series.

Workings.—The Redcliff croppings occur on a steep slope and the workings consist of two tunnels driven from the surface and an intermediate level. The upper level starts in the croppings of the main ore body at an elevation of 950 feet above sea-level and about 100 feet above Lydden creek. It passes through the main ore body at a distance of 70 feet from the portal, but has been continued through hard blocky country in the same westerly direction for a further distance of 160 feet in order to undercut a second ore body which outcrops on the surface above. No ore was found and the ground to the left is now being explored by a drift starting 180 feet from the portal and following a strong fissure.

The lower tunnel starts well out in the valley at an elevation of 680 feet and has been driven under Lydden creek into the mountain in a northerly direction for a distance of 1,410 feet. A long exploratory drift to the left branches off at 1,100 feet from the portal and a second one at 1,300 feet. At 1,365 feet a raise has been put through to the upper level. The raise is in two sections connected at a point 65 feet below the upper tunnel by

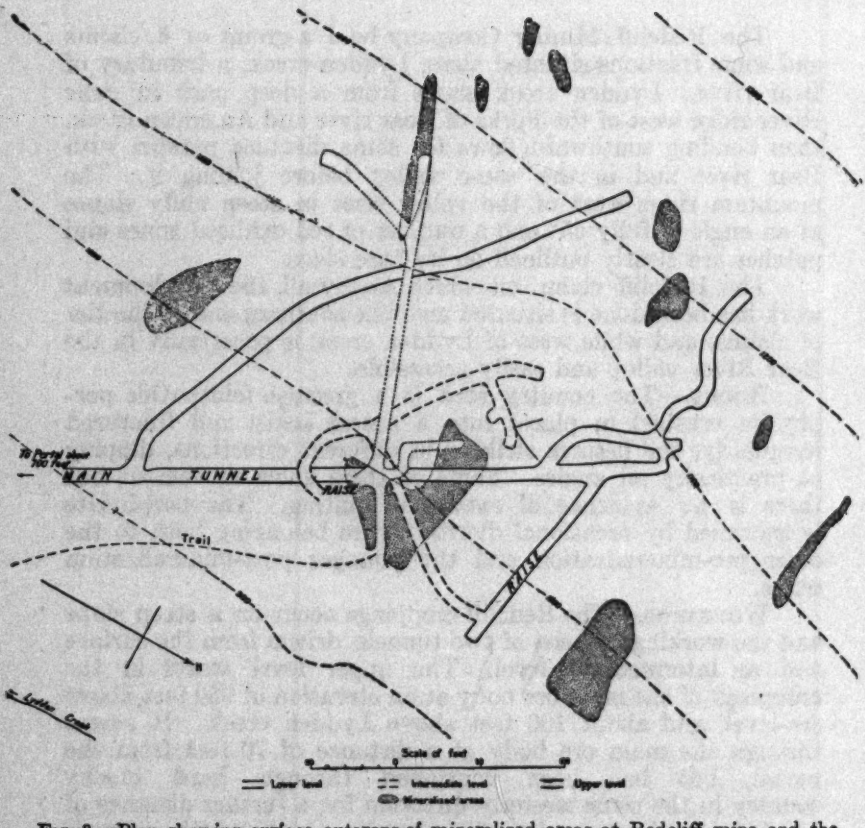

FIG. 3.—Plan showing surface outcrops of mineralized areas at Redcliff mine and the mine workings

a drift 110 feet in length known as the intermediate level. The first section follows a steep well defined fissure bordered in places by bunches of ore. The second section is nearly vertical and reached the ore body exposed in the upper workings about 40 feet beneath the tunnel level. Besides the connecting tunnel at the Intermediate level, a considerable amount of drifting has been done in an attempt to find the downward extension of the ore body exposed above.

Ores and Ore Bodies.—The result of the extensive exploratory work on the Redcliff up to the present has been disappointing on the whole, as while ore has been found at a number of points on both the lower and intermediate levels none of the occurrences have much persistence as workable masses. A number of small and moderate sized lenticular and irregular shaped ore bodies outcrop on the surface of the claim. The largest of these, that cut in the upper workings, has a length at that level of 75 feet, and a width of from 5 to 17 feet. It has a proved downward extension below the level as shown in the raise of 40 feet, and it continues above the level to the sloping surface a distance of 100 feet at the highest cropping.

A second ore body about 100 feet long and from 4 to 6 feet wide outcrops on the hillside 100 feet above that opened up. The upper level has been extended to a point immediately below it in an attempt to undercut it in depth, but so far without success.

The lenses or ore bodies are irregular in outline, and are only occasionally bounded by definite fissured walls. While probably deposited along zones of weakness, this is not evident either on the surface or in the workings. Fissures occur in their vicinity, some crossing and apparently younger than the ore body, but are not more numerous or better marked than in places showing little mineralization.

The gangue matter is mostly the altered country rock, usually silicified to some extent, and seamed in places with small irregular quartz veins. Some calcite is also present. The metallic minerals are chiefly pyrite, pyrrhotite, and chalcopyrite, with a little zinc blende. The chalcopyrite occurs in grains, small solid bunches, and in narrow bands alternating with the pyrite; and both the pyrite and chalcopyrite contain some gold, and silver values.

The average copper tenor of the ore extracted from the workings is estimated at from 4 to 5 per cent. An assay of a general sample of an occurrence of ore in the intermediate level showed—gold 0·13 ounce per ton, silver 2·00 ounce per ton, copper 4·89 per cent.

EQUIPMENT.—The mine is equipped with a ten-drill compressor and an electric lighting plant, both now operated by water power furnished by Lydden creek. The railway was completed to the mine during the season, and bunkers of 700 tons capacity erected. These are situated near the railway track and are connected with the main tunnel by a gravity tram 800 feet in length.

A number of other showings, some seemingly important although little or no work has so far been done in them, occur in the tier of claims owned by the Redcliff Mining Company. Ascending Lydden creek a large patch, reddened irregularly and fully 100 feet across, occurs at the top of a steep talus slope near the junction of the Redcliff and Little Pat claims. The mineralization is more scattered than in the Redcliff showing, and consists mostly of pyrite, with some chalcopyrite in spots. The average values are not known. Farther up Lydden Creek canyon an outcrop of ore on the Montrose claim has excited considerable interest on account of the high gold values it contains. The exposure, as seen in the cliff rising up from the valley bottom, has a length of 35 feet, and a minimum width of 15 feet, and consists of the country rock more or less completely replaced with quartz and pyrite. Some galena and copper carbonates occur along the inner wall. Assays of over $100 per ton in gold have been obtained from the pyrite in this ore body. Other wide croppings occur farther up the valley in the same line, and also on the opposite side of the canyon a short distance lower down.

Ouray and Big Casino.

Some exploratory work was done on these claims in 1910 by the Big Casino Mining Company. They are situated on the same mountain as the Redcliff, but farther up Lydden creek and at a much greater elevation, the altitude at the Big Casino workings, as registered by the aneroid, being 3,140 feet above sea-level. A zigzag pack trail has been built up the steep mountain side to the showings.

The Ouray showing occurs in a fissured zone, about 15 feet wide where best seen, traversing the Bear River greenstones in a southeasterly direction, and dipping to the northeast. The lead has been stripped for a distance of 200 feet. It consists of the fissured country rock, sparingly silicified and mineralized with galena, pyrite, and some chalcopyrite in scattered grains and bunches.

The Big Casino showing has a width of 35 feet, and has been stripped for 60 feet. It contains considerable quartz, and is mineralized with pyrite, chalcopyrite, and bunches of galena.

A drift along the lead had just been started at the time of my visit.

Initial Group.

This is situated south of Big Casino group on the same mountain, but towards the Goose Creek slope, at an elevation of 3,135 feet. A band of granitic rocks and quartz porphyrites runs northwesterly from Bitter creek up Goose creek and across to the Salmon river, and the main showing occurs near the northern junction of this with the Bear River greenstones. The showing consists of two mineralized zones, one 6 to 12 feet in width, and the other up to 25 feet in width, separated by a felsitic dyke. The leads strike N. 30° W., dip towards the granitic belt, and are irregularly mineralized with pyrite, chalcopyrite, and galena. Very little work has been done on them.

Redcliff Extension.

The Redcliff extension is situated high up on the slopes of the mountain north of Lydden creek, at an altitude of 3,500 feet above the sea. The rocks here are a slightly schistose variety of the Bear River greenstones. The greenstones are traversed by a zone of fissuring running nearly east and west.

This has been opened up by two surface cuts about 100 feet apart, and 100 feet lower down the slope an exploratory drift along the lead has been started. The lower cut exposes a small lens of good chalcopyrite ore. At the upper cut the fissured country rock is largely replaced, for a width of 12 feet, with quartz, often red and jaspery, and calcite, and carries some pyrite, and small quantities of galena and chalcopyrite.

Mountain Boy.

This claim is one of the oldest in the district, having been staked in 1902. In 1910 some work was done on it by the Pacific Coast Exploration Company. It is situated in the lower slopes of the mountain ridge, bordering American creek on the west, about 4 miles above its junction with Bear river. The rocks here belong to the Bear River formation but are more porphyritic than usual, and are often reddened irregularly. They are slightly schistose in places.

The showing occurs at the top of a steep talus slope, at a height of about 1,000 feet above the valley bottom and 2,200 feet above the sea, and at first glance is a somewhat imposing one, as the fissured and broken country rock for a width of about 25 feet is almost completely replaced by a mass of quartz,

calcite, and barite, which projects along the surface in a pinnacled cliff. The lead strikes nearly east and west, and dips to the south at an angle of 50°. Traced up the steep hill it soon becomes less well defined, the proportions of secondary minerals present gradually diminish and at a distance of 150 feet it is represented only by small stringers. The extension of the lead downwards towards the valley, if any, is buried beneath slide material.

The Pacific Coast Exploration Company was occupied most of the season of 1910 in the necessary preliminary work of trail building, erecting winter quarters, etc., and had not commenced actual mining at the time of my examination. The old workings consist of a tunnel about 100 feet long, which starts on the lead, but soon leaves it and then bends gradually round to the left in an effort to pick it up again. It affords little information.

The metallic minerals present consist mostly of zinc blende, galena, pyrite, and chalcopyrite distributed somewhat sparingly in grains, veinlets, and small bunches through a mixed gangue of quartz, calcite, and partially altered country rock. The deposit, as a whole, is low grade so far as explored, although fair assays, mostly in silver, are reported from portions of it. Some good oré occurs along a cross fissure which cuts the lead 75 feet above the portal of the tunnel.

Several parallel zones, of mineralization, all somewhat similar to the one just described, occur in the vicinity.

CLAIMS IN MOUNTAINS BETWEEN BEAR RIVER AND AMERICAN CREEK.

Bonanza.

The Bonanza claim is situated between Bear and American creeks, about a mile above the junction, and at an elevation of 400 feet above it. The showing occurs in a band of slates enclosed in theBear River greenstones, and consists of a narrow vein made up of brecciated slate and quartz, holding a small seam of nearly solid galena, from 2 to 5 inches in thickness. The galena seam is exposed on the surface, and in a pit sunk on it for a distance of 40 feet. An open-cut, 75 feet farther north-northwest along its strike, shows the lead, but it is here less well mineralized.

The galena occurs in a coarse, cubical condition and is associated with a little chalcopyrite, blende, and pyrite. The pure galena is stated to give values of $90 in lead and silver.

Catchem.

The Catchem claim is situated east of American creek, about 2½ miles above its forks with Bear River, and the showing on it is very similar to that on the Bonanza. The country rocks consist of a band of argillites and tuffs in the Bear River greenstones. Some of the beds contain considerable lime in small lenses following the bedding planes. These weather readily, and on exposed surfaces the rock has a honeycombed appearance.

The lead or fractured zone has a width of 5 or 6 feet, and contains on the hanging wall a seam of nearly pure, mostly fine-grained galena up to 6 or 8 inches in thickness. This is followed by 2 feet of broken country rock, carrying some galena in small stringers and bunches. The workings are insufficient to define the extent of the deposit either in strike or depth. A long tunnel to undercut the lead at some depth has been started but not completed. Assays of the ore show from 45 ounces to 107 ounces in silver per ton, while one exceptional specimen is said to have run several hundred ounces.

Glenora.

The Glenora claim, owned by the Northern Terminus Mines Company, is situated high up near the timber line in the mountains bordering American creek on the east, nearly opposite the Mountain Boy. The country rock in the vicinity includes both the massive and fragmental varieties of the Bear River greenstones. The workings at the time of my visit consisted of a pit 8 feet deep, sunk on the deposit. This exposes a diabase dyke 2 feet wide dipping to the east at an angle of 45°. Resting on the dyke is a seam of nearly clean galena with some blende, 8 inches in thickness. A second vein from 3 to 6 inches wide underlies the dyke and is followed at one point by 3 feet of silicified, altered country containing some galena. The veins have only been uncovered for 15 feet. The ore runs high in silver, a sample collected showing 146·59 ounces per ton.

Ruby No. 2 Claim.

This claim, owned by the Portland Bear River Mining Company, is situated on the Bear River slope of the mountain ridge between Bear river and American creek, at an elevation of 2,700 feet above the sea. The rocks in the vicinity consist mostly of greenstone agglomerates belonging to the Bear River formation, with some included argillaceous bands. The principal showing consists of a quartz vein following one of the slaty bands. This has been opened up by a drift 150 feet in length.

The vein striking to the north and dipping steeply to the west was followed for 120 feet, then disappeared. It is also exposed for a short distance in cuts south of the portal of the drift. The width of the vein varies from a few inches up to 2 feet. The quartz contains numerous slate fragments and is stained yellow in places from iron. Pyrite in small scattered grains is the principal metallic mineral present. The surface croppings of this vein are reported to have shown free gold. A general sample of the vein material on the dump gave on assay, gold, 0·25 ounce, and silver, 12·60 ounces per ton.

CLAIMS ON BEAR RIVER ABOVE AMERICAN CREEK.

Independence.

This claim is situated in the Bear River canyon, a constricted portion of Bear River valley, a mile and a half above the American Creek forks, and was explored in 1910 under bond by the Bear River Canon Mining Company. The showing occurs in a band of slates, tuffs, and limestones enclosed in the Bear River greenstones. These are traversed in a nearly north and south direction by a well marked line of fissuring which follows closely the strike of the rocks. The fissure has been drifted on for a distance of 140 feet. A lens of nearly solid galena with some blende, about 8 inches in thickness, which outcropped on the surface, was cut through in a distance of 20 feet. A second lens, consisting mostly of blende with some galena, was encountered at 50 feet and followed for 12 feet, and beyond that the fissure proved barren. A shaft at the mouth of the tunnel followed the galena lens down to a depth of 15 feet, when it disappeared.

Similar narrow lenses of galena ore occur on what seems to be the same line of fissuring, on the Victor claim north of Bear river, but have not been investigated.

Bear River Mining Company.

This Company prospected in 1910 a group of claims situated south of Bear river, some distance above the Bear River canyon. The country rocks consist mostly of greenstone agglomerates often silicified over large areas, and belonging to the Bear River formation. Reddish oxidized zones and patches, some of considerable extent, are numerous in the vicinity. One of these on the New York claim has been opened up by a short drift. It consisted mostly of pyrrhotite distributed irregularly through the country rock, and associated in places with a little chalcopyrite. It is of considerable size but the

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Mountains west of Bromley glacier. Shows diorite porphyry dykes traversing Bitter Creek argillites.

values are small. A second mineralized mass fully 30 feet wide occurs in the London claim; iron pyrite is the principal mineral present. The gangue, mostly the altered country rock, contains garnets in disseminated crystals.

Float chalcopyrite ore occurs in some quantity in the wash of a glacial stream which descends from the mountain, a short distance east of the London claim. The region at the head of the stream is exceedingly precipitous and difficult to explore, and the source of the ore has not been definitely determined.

Copper King and Copper Queen.

These claims are situated high up on the range of steep craggy mountains bordering Bear river on the south near its head. The Bear River greenstones which form the country show shattering along a wide zone tending east and west. Along this there is a development in places of small irregular quartz seams, bunches and seams of calcspar, and areas are heavily pyritized. Chalcopyrite is present in portions of the zone but so far has not been found in workable quantities.

CLAIMS ON BITTER CREEK.

Black Bear Group.

These claims are situated southwest of the Bromley glacier, the source of Bitter creek, $2\frac{3}{4}$ miles above the snout of the glacier, and 10 miles above the mouth of Bitter creek. They were the cause of considerable excitement owing to the spreading of exaggerated accounts in regard to the size and richness of the leads which cross them.

The rocks along the southwest side of the Bromley glacier consist mainly of the dark grey Bitter Creek argillites. They are less altered than on Glacier creek, are often striped and include occasional tufaceous bands. They strike nearly north and south, and dip regularly to the west at angles of from 38° to 40°.

A prominent feature of the geology is the number of large greyish dioritic dykes which alternate with the dark argillites. They run nearly horizontally along the bare steep mountain slopes and look like a succession of sills. They conform, as a rule, very closely to the dip and strike of the argillites, but occasionally cut across them at a considerable angle. The series of brownish weathering, post metalliferous dioritic dykes are also well represented.

The leads consist of crushed and silicified zones of various sizes up to 15 or 20 feet in width, which, like the dykes, follow closely the dip and strike of the argillites. The principal croppings occur on Gold Bluff No. 2 claim, at a height of 600 feet above the glacier, and about 3,700 feet above the sea. The lead at the point examined consists of about 15 feet of quartz and silicified argillites, holding considerable iron pyrite in places. A number of smaller showings occur at various other points in the vicinity, some of which are sparingly mineralized with chalcopyrite and galena in addition to the pyrite.

The pyrite in the main lead where examined is gold bearing, but the values are much too low to constitute it a commercial ore under present circumstances. It is, however, only accessible at one or two points, and it is possible that in other portions of its course better values may be present. Good looking float occurs in some abundance along the foot of the slopes, but the source of this has so far not been determined.

Old Chum Group.

These claims are situated about a mile up Hartley gulch, a steep mountain torrent which joins Bitter creek from the east, three-fourths of a mile above the termination of the Bromley glacier. The principal showings occur on Old Chum No. 2 claim, and consist of three fissured and mineralized zones in a space of 130 feet, traversing slates in a direction a few degrees south of east. The centre lead is about 4 feet wide, and is made up of quartz and decomposed and reddened slates. The slates bordering it are broken and pyritized for some distance. It contains galena in grains and bunches, and iron pyrite. The pure galena carries 80 ounces in silver and $2 in gold per ton. The south lead is seamed with quartz stringers for a width of 15 feet, and mineralized with iron and a little chalcopyrite and blende. The north lead is about 6 feet wide, and mineralized chiefly with pyrite. The workings consist of some surface cuts and a short tunnel.

L. L. and H. Group.

The claims in this group are situated on the north side of Hartley gulch a short distance below the Old Chum group. The argillites here are intruded by greenstones, and are contorted and broken. The principal showings occur on the Union Jack and Famous claims, and consist of three nearly parallel lines of fissuring, one of which, the centre one, is traceable along the precipitous slopes which border the valley for a distance of about 1,000 feet. The width of the fissured and partially

silicified and altered zone varies from a few inches to 6 feet. The mineralization is irregular and consists mostly of iron with some arsenical pyrites. Small quantities of galena and chalcopyrite are also present in places. The pyrite carries significant gold and small silver values. A coarse-grained variety yielded $8 in gold and $1.38 in silver per ton, and better returns have been obtained from selected samples.

The upper lead has a width of over 10 feet and carries considerable galena. It has not been traced out.

The workings in 1910 consisted of a short cross-cut tunnel into the footwall of the upper lead. In 1911 a cross-cut tunnel intended to intercept the two upper leads was driven in for a distance of 100 feet. The upper lead was not reached on account of a flow of water. The centre lead, where cut, is reported by the owners to have a width of 4 feet and to carry values of $15 per ton in gold and silver.

Roosevelt.

The Roosevelt is situated on the north fork of Bitter creek near the bottom of the valley, about a mile above its junction with the main stream. The Bitter Creek argillites, which form the country rock in the vicinity, are cut and disturbed by numerous dykes referable to three periods. The oldest set is much altered, and consists of greenstones, probably of the same age as the intrusive area at the head of Glacier creek. These are cut by large greyish dioritic dykes, and also by the later set of brownish weathering dioritic dykes.

The main lead occurs below one of the greenstone dykes and has been followed by a drift for a distance of 70 feet. It consists of 5 feet of broken and silicified country rock, carrying some pyrite and chalcopyrite. The mineralization diminishes towards the end of the drift. A small lens of good chalcopyrite ore has also been uncovered above the dyke. A good trail to the claim was built in 1910 and a bunk house erected, but little mining work was done.

Bitter Creek Mining Company.

This Company owns a group of thirteen claims situated along a small stream which enters Bitter creek from the north, immediately below the North fork. Some work has been done on the Cupron and Swede-American No. 14. The latter is situated above the timber line, at an elevation of about 4,000 feet above the sea. A lead about 12 feet wide occurs on it. This when examined in 1910 had been drifted for a distance of 45 feet. It consisted of crushed and broken argillites, often

partially decomposed, seamed with numerous irregular veins of quartz and calcite. The metallic minerals present are galena, blende, and iron pyrite. The pyrite is stated to carry good silver values. The lead is a strong one but the workings showed no continuous body of commercial ore.

The Cupron showing is situated lower down the creek at an elevation of 1,650 feet above sea-level. It outcrops in the creek bottom, and is exposed for a distance of 60 feet. The lead has a thickness of about 5 feet, and consists of a broken slate gangue, with bunches and stringers of quartz and calcite, well mineralized in places with chalcopyrite, galena, and pyrite. A cross-cut tunnel to intercept the lead in depth has been started but not completed.

Olga.

The Olga is situated east of Bitter creek about 3 miles above its mouth. The showing consists of a quartz vein traversing the Bitter Creek argillites which form the country in a northeasterly direction, and dipping to the southeast. The workings include a cross-cut tunnel to the vein 72 feet in length and a drift along it 130 feet in length. Chalcopyrite in bunches and small aggregates is exposed along the drift for a distance of 60 feet, but is too sparingly distributed to constitute a commercial ore.

Gold Bar No. 1.

This claim is situated south of Bitter creek about a mile above its mouth, and at an elevation of 1,000 feet above it It contains a quartz vein, which follows the ragged contact between a granite area and the Bear River greenstones which it intrudes. The quartz vein has a width of from 4 to 10 feet, and is stripped at intervals for a distance of 150 feet. It is reported to carry some gold values, but no assays were seen.

A second quartz vein, or a continuation of the first, outcrops on the Blue Bells No. 1 claim 400 feet to the south.

PART II.

SALMON RIVER DISTRICT

BY

R. G. McConnell.

PART II.

SALMON RIVER DISTRICT.

TOPOGRAPHY.

Salmon river parallels Bear river on the north and is separated from it by the long Bear River ridge. It is a short stream issuing from a large glacier, and after a course of 13 miles measured along the valley, empties into Portland canal near its head. The main stream is entirely in Alaskan territory, the International Boundary line crossing its valley near the lower end of the glacier.

South of the Salmon glacier, between it and Bear River ridge, is a broken ridgy tract of country, about 2½ miles wide, drained by Cascade river, a tributary of the Salmon. Most of the mineral occurrences are situated along this belt.

Cascade river heads in Long lake, plunges down a series of cascades through a recent rockcut channel into Silver lake, then continuing southward, joins the Salmon after a course of about 5½ miles measured along its valley. Its grade is exceptionally steep, averaging over 500 feet to the mile. It has a width of from 20 to 50 feet, flows a large volume of water, and if the prospects now being investigated develop into mines, will doubtless be utilized at several points for power plants.

A branch to the northeast, separated from the main stream by Slate mountain, a long ridge rising to an elevation of 4,000 feet, skirts the base of Bear River ridge to a point close to Long lake and at about the same elevation. It is fed by streams descending from the snow and ice-covered slopes of Bear River ridge, and near its mouth is almost equal in size to the main stream.

Long lake, the source of Cascade river, is a narrow stretch of water about a mile and a half in length, occupying a depression in a north and south trending valley separating Mt. Dillsworth[1] from Bear River ridge. Its elevation is approximately 3,250 feet. The valley beyond it rises slowly northward to a flat summit, then descends towards the Nass slope.

The principal elevations of the district include: the long Bear River ridge, bounding it on the east; Slate mountain,

[1]Named after one of the pioneer prospectors of the district.

4,000 feet high, between the two branches of Cascade river; the Big Missouri ridge, 3,400 feet, between Cascade river and Salmon glacier, and Mt. Dillsworth, a round dome-shaped, completely snow-covered elevation, rising to an altitude of 5,600 feet between Long Lake valley and Salmon glacier. Skirting the southern base of Mt. Dillsworth is a narrow, broken, and hummocky belt sloping towards the Salmon glacier. Mt. Miter, so called by the miners on account of its notched summit, is a conspicuous object in the view up Long Lake valley. It has a broad spreading base deeply buried in snow and ice from which a bare, seemingly almost perpendicular, mass of rock shoots up to a height of over 8,000 feet.

The glaciers of the district are a prominent feature. Salmon glacier, the source of Salmon river, has a length of nearly 8 miles and occupies the summit of a through valley connecting the Salmon with the Nass. It is fed mainly by two branches from the west, one joining it at the summit almost at right angles and from this the ice flows east and west down both slopes. Its elevation at the summit is approximately 3,000 feet and at its termination in the Salmon valley 480 feet, the lowest point reached by perennial ice in this portion of the Coast range. The Nass branch ends in a lake at a much higher elevation. A number of small glaciers descend from the large permanent snow-field which crowns Mt. Dillsworth, and a line of ice tongues creep down the slopes of the Bear River ridge, none of them reaching the valley. The western slopes of this ridge are less steep than those fronting on Bear River and American creek and large snow-fields are more prominent.

The general aspect of the Salmon River district above an elevation of 3,000 feet is exceedingly bleak and arctic looking. Long lake at the time of our visit, August 2, was still covered with ice, and except on projecting rocky knobs and sunny slopes the preceding winter's snow lay thick everywhere. Below an elevation of 3,000 feet, the valleys and mountain slopes are generally well wooded, principally with large hemlock and spruce of good quality.

GEOLOGY.

The formations represented in the Salmon River district are the Bear River greenstones, the Nass argillites, and the granitic rocks of the Coast Range batholith.

The eastern edge of the Coast Range batholith on the western slope of Bear River ridge, and in the Salmon River valley, occurs on the Alaskan side of the International Boundary and was not traced out. Following the boundary line, small granitic areas, some of which may be spurs from the main

batholith, and large dykes, are crossed at intervals, but the predominant rock is greenstone. On the western side of the Salmon valley the eastern edge of the batholith trends to the north and crosses the International Boundary near the lower end of Salmon glacier. It follows the glacier for 3 miles, to a point above the first feeder, then turns more to the west and passes beyond the district examined.

A band of granitic and porphyritic rocks, roughly paralleling the main batholith at a distance of from 4 to 6 miles, crosses into the Salmon valley from the head of Goose creek, and extends in a northwesterly direction across Long lake to the base of Mt. Dillsworth, then bending more to the west crosses Salmon glacier to a mountain south of the main feeder at the summit. The width of the band is variable, in places exceeding half a mile and in others diminishing to a few hundred feet. West of Long lake, it becomes very narrow and soon breaks up along its course into a series of large parallel dykes dipping to the southwest.

The rocks in this band are usually porphyritic and in places pass into typical quartz porphyries made up of quartz, and plagioclase feldspar phenocrysts, with some white mica embedded in a fine-grained, micro-crystalline base. In the main batholith west of the Salmon glacier the prevalent variety, as shown in a couple of sections, is a coarse grano-diorite with hornblende often in well formed crystals as the principal dark mineral. The other essential constituents are plagioclase feldspar, quartz, and a little orthoclase.

BEAR RIVER FORMATION.

This is the most widely distributed formation in the Salmon River district. It occurs bordering the granite a little to the southwest of the International Boundary, on the western slope of Bear River ridge and in the Salmon valley, and except where overlain by occasional patches of the Nass argillites and cut by granitic dykes and areas, underlies the region east of the Salmon glacier as far north as examined.

The Bear River formation is predominantly a greenstone formation and represents the products of a long period of vulcanism. The rocks include fine, medium, and coarse volcanic breccias or agglomerates, tuffs, bands, and areas of massive porphyrites, and occasional argillaceous bands. The fragmental rocks are often difficult to separate from the massive rocks in the field and even in thin sections. They are seldom distinctly bedded or banded, and often appear massive through sections hundreds of feet in thickness. The fragments are

angular or subangular, consist mainly of feldspathic porphyrites, and on fresh surfaces are often indistinguishable from the matrix, although plainly outlined where the rock is weathered.

In the Salmon valley, the greenstones are usually sheared and pass into coarse greenish and greyish schists, the lines of schistosity being roughly parallel to the eastern edge of the Coast Range granitic batholith and dipping towards it at a high angle. The shearing is irregular, some areas being only slightly affected, and usually, but not invariably, increases in intensity approaching the granite.

NASS FORMATION.

The rocks of the Nass formation overlie the Bear River greenstone. They occur on the northern part of Slate mountain and extend northeasterly in a comparatively narrow band west of Long lake to the eastern shoulder of Mt. Dillsworth. A second area, separated from the first by the erosion of the valley of the East fork of Cascade river, is exposed east of Slate mountain in the western slopes of Bear River ridge. This area is largely buried in snow and ice and its upper contact with the greenstone was not seen. A third area, tentatively referred to the Nass formation, occurs bordering the Coast Range granitic rocks west of the Salmon glacier.

The rocks of the Nass formation are mainly dark argillites, always more or less altered and in places cleaved into slates. On Slate mountain they are fine-grained and very uniform in composition throughout. They rest on a massive-appearing, dark-coloured, volcanic breccia, below which are the greenish schistose fragmentals of the Bear River formation. On the western slope of Bear River ridge and north of Long lake, the argillites are associated with greenish and greyish beds and bands of tufaceous sandstone. The material in these consists mostly of angular quartz and feldspar grains with fragments of slate and calcite.

In the area west of the Salmon glacier they consist of hard, siliceous, dark and striped slaty rocks resembling quartzites in places.

The Nass argillites and associated granular and fragmental beds occupy the Long Lake depression, and rise to the south in Slate mountain and the western slope of Bear River ridge. They have been folded in the mountain-making movements, and in places crushed into the underlying Bear River greenstones. The dips and strikes, while irregular, indicate a double fold trending in a north-northwest direction. The formation extends northwards beyond the district examined and its thickness was not ascertained.

ECONOMIC GEOLOGY.

The mineral occurrences of the Salmon River district occur altogether in the Bear River schistose greenstones, and consist mostly of silicified zones often of great width, carrying varying quantities of iron, lead, zinc, and copper sulphides. Fissuring occurs in connexion with some of the deposits, but few of them are bounded by sharp walls and in most cases the cessation of the mineralization is gradual. The mineralized zones are really bands of country rock sometimes 50 feet in width, partially and in limited areas wholly replaced by silica and various sulphides. A few quartz veins occur in addition to the replacement deposits, and in some instances carry high grade silver minerals.

A large number of claims have been staked on these mineralized zones, extending in an almost continuous line, often several tiers deep, from the International Boundary, up Cascade river, along the Big Missouri ridge, and the lower slopes of Mt. Dillsworth to near the summit of the Salmon glacier. While staking has been active the progress of development and exploration work has been very slow, this consisting only, with the exception of a couple of short tunnels, of small open-cuts and cross trenches. None of the showings have been advanced beyond the stage of surface prospects. This slow progress is due in large measure to the absence of transportation facilities and the consequent extravagant cost of supplies. The building of trails has been delayed by the fact that while the showings are mostly on the Canadian side of the International Boundary, the road to the coast passes through Alaskan territory.

MINERAL CLAIMS AND PROSPECTS.

The first camp reached ascending Cascade river is that of Bunting Bros. and Dillsworth, situated at an elevation of 1,050 feet on the eastern bank of the East fork of Cascade river about a mile northeast of the International Boundary and 12 miles from Portland canal, following the Salmon valley. A joint stock company, under the name of the Cascade Falls Mining Company, has recently taken over the five claims owned by this syndicate.

The principal showing occurs on Cascade Falls No. 2 claim, and consists of a mineralized zone traversing the greenstone schists which form the country rock in an easterly direction. The schists for a width of over 30 feet are altered and strongly silicified and pyritized. In portions of the zone, galena is present in considerable quantities, associated with some zinc blende and occasional grains of chalcopyrite. A rough sample across 8 feet

of the best mineralized portion of the lead assayed in the laborarory of the Department of Mines, yielded:—

Gold	0·14 oz. per ton.
Silver	7·00 ozs. per ton.
Lead	7·60 per cent.

Ore of this grade could doubtless be mined at a profit in the district if present in quantity, but the extent to which it persists either in depth or along the strike of the lead has not been demonstrated. The mineralization is irregular both across the lead and along its strike, portions of the zone containing little or no galena, the principal silver-bearing mineral; and the present workings are limited to a shallow cut in the steep hillside across the lead and some surface stripping. The prospects are, however, considered favourable enough to justify a considerable expenditure for further exploratory work.

Salmon-Bear River Mining Company.

This Company owns seven claims situated a short distance east of the Bunting-Dillsworth group, and about 1,000 feet higher up the western slope of Bear River ridge. One of them, Cascade Falls No. 4, contains a very wide showing. The schists are silicified, seamed in places with small irregular quartz seams, and impregnated with sulphides for a width of fully 75 feet. The sulphides are oxidized on the surface and the mineralized zone is traceable up a steep hillside for a distance of about 200 feet, beyond which it is concealed.

The workings consist of a shallow cut across the greater portion of the zone near the base of the hill and a short tunnel higher up the slope. These show the mineralization to be very irregular, portions of the zone being entirely replaced by sulphides and quartz and others only slightly affected. Quartz and the iron sulphides are the only minerals which persist across the zone. Galena occurs in small veinlets, bunches, and scattered through areas and bands in the zone, and some sphalerite and occasional grains of chalcopyrite are also present. The galena areas carry fair values in lead and silver and some gold, and the value of the deposit depends on their permanence. The present workings are, of course, wholly insufficient to determine this point.

The Pictou claim belonging to the same Company, situated about 1,000 feet northwest from the main showing, is crossed by a second, somewhat similar, but smaller zone, apparently following a strong diorite porphyry dyke. The schists for a width of 20 feet from the dyke, as shown in a small transverse cut, are silicified, heavily mineralized with pyrite and some galena, cut

by numerous quartz stringers, and in places brecciated. A hundred feet to the northwest, a second cut exposes a similar zone on the opposite or southwest side of the dyke. The proportion of galena present in the cuts is small and its distribution is bunchy and irregular.

The Simpson claim in the same group, situated higher up the slope, contains an exposure of silicified schist cut by quartz stringers, some of which carry small quantities of native silver and chalcocite in addition to the ordinary pyrite and galena. High assays in silver and some gold have been obtained from picked samples. The lead is concealed except at a couple of points, and no attempt to trace it out has so far been made.

Indian Mining Company.

This Company owns four claims, situated at an elevation of about 2,400 feet, near the southern end of the Big Missouri ridge between Cascade river and the Salmon glacier. The principal showing occurs on Portland No. 2 claim, and some development work was done on it in the season of 1910 by the Portland Salmon River Syndicate, and is described in the Summary Report of the Survey for that year. During the past season a couple of men were engaged extending an exploratory tunnel started by the syndicate.

The lead crosses diagonally a wide dyke or lenticular dioritic stock very much altered, which intrudes the greenstone schists, and is better defined than most of the showings in the district. A cut across it near the summit of the ridge shows it to have a width here of nearly 20 feet, and exposes from 5 to 8 feet of nearly solid galena bordered by quartz and silicified and mineralized country rock. The galena mass has been followed vertically for 20 feet, but apparently does not extend far along the strike. A second cut, 150 feet to the south-southeast, down a steep slope, shows little galena. The lead here consists mostly of altered and silicified country rock and carries average values in gold and silver of about $10 to the ton across a width of 10 feet.

The tunnel now being driven starts 300 feet south-southeast of the galena showing and will undercut it at a depth of 150 feet, as the surface falls rapidly in that direction. At the time of my visit the face was in low grade ore, a sample assayed in the laboratory of the Department of Mines yielding 0·11 ounce gold to the ton, 1·10 ounce of silver, and 5·12 per cent lead. The extension of the tunnel is important, as when completed it ought to furnish valuable information in regard to the general character of the deposits of the district.

Some surface prospecting was in progress during the season on mineralized areas and zones on the Siwash and other claims on the Big Missouri ridge north of the Portland group, but no conclusive results were obtained. The Big Missouri claims and the thirty odd claims held and prospected to some extent in the season of 1910 by the Golden Crown Mining Company were all idle, the bond on them held by that Company having been thrown up. The Martha Ellen and three other claims held under bond in 1910 by the Salmon Glacier Mining Company and situated farther to the north immediately above the Salmon glacier, were also idle although very satisfactory results had been obtained from the small amount of surface prospecting done. A trench across a mineralized zone on the Martha Ellen, roughly sampled for 17 feet, yielded 0·57 ounce gold to the ton, 3·76 ounces silver, and 4·64 per cent lead. The zone has a width of over 50 feet and the most highly mineralized portion is not included in the sampling, as a deep transverse pit filled with ice and water prevented access to it. Still farther to the north, between Mt. Dillsworth and the Salmon glacier, are the Fortynine and numerous other claims, all staked on oxidized zones and areas, but with little work done on them.

The Silver Flat, on a hill north of Silver lake, affords an example of a narrow lead confined between nearly vertical fissures. The lead has a width of from 2 to 3 feet and consists of quartz and silicified country rock carrying some galena, chalcopyrite, sphalerite, and pyrite. Assays of $21 to the ton in gold, silver, and lead are reported.

SUMMARY.

Characterizing the region generally it may be stated that it contains a large number of mineral deposits ranging in size from small stringers to wide zones and irregular lenses often 50 feet and more across, all traversing the more or less schistose massive and fragmental greenstones of the Bear River formation. The deposits plainly follow lines of fissuring and shear zones in some instances, and probably do so in all cases. With the exception of some narrow quartz stringers they all belong to the replacement class, and in origin and the irregular and hazy outlines of some of the masses resemble contact metamorphic deposits, but the characteristic non-metallic minerals which accompany these were seldom observed and are nowhere present in quantity.

The gangue is invariably the more or less completely silicified country rock, and the common metallic minerals are pyrite, occasionally pyrrhotite, galena, sphalerite, and chalco-

pyrite. Of these pyrite is much the most abundant, and in some cases is practically the only mineral present. In places it carries appreciable values in gold. A specimen of pyrite in a quartz gangue from Cascade Falls No. 2 yielded 0·24 ounce of gold to the ton and much higher assays are reported. Chalcopyrite was not observed in workable quantities. Galena is more abundant and usually carries silver values averaging about one ounce to the unit of lead. The distribution of the galena in the silicified and pyritized zones and areas is usually irregular, some portions carrying a good percentage while others are entirely barren.

Development work has been retarded by the lack of transportation facilities and consists only of some surface cuts, trenches, and a few short tunnels. These in several instances have exposed bodies of ore carrying values in gold, silver, and lead of from $10 to $20 per ton. Development work has not, however, proceeded far enough to show what persistence these ore bodies have either in strike or dip. The mineralizing solutions undoubtedly came from the underlying granite, and there is no reason why the deposits should not descend to considerable depths, but whether in irregular unworkable bunches or in continuous pay shoots still remains to be proven.

PART III.

RECONNAISSANCE TRIP TO THE NASS VALLEY.

BY

R. G. McConnell.

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PART III.

RECONNAISSANCE TRIP TO THE NASS VALLEY.

ROUTE TO NASS VALLEY.

In August a short trip was made across the Coast range to the Nass valley to examine some quartz and placer properties staked on the east slope of the Coast range. The trip was made in company with Mr. Porter, a prominent prospector in that region, and Mr. MacIntolmy, a claim owner.

The route followed was up the Bromley glacier to McAdam point, near the southern end of the Cambria range. Here the Bromley glacier divides into three main branches, one swinging to the south along the base of Mt. Trevor towards the high snow-covered pass from Bitter creek to Marmot river, and the two others heading in a long, comparatively narrow snow-field occupying a high longitudinal valley west of the Cambria range and extending southwards for an unknown distance towards the head of Hastings arm of Observatory inlet.

From McAdam point a steep ice slope 1,000 feet high was climbed, then turning to the northeast the snow-filled valley west of the Cambria range was followed, gradually rising for 5 miles to a flat, barely perceptible summit at an elevation of 5,750 feet, then descending slowly at first but with gradually increasing grade towards the Nelson glacier and creek tributary to the Nass. This great snow valley is an important feature of the Coast range. It has a width of from 1½ to 2 miles or more and a length of over 20 miles in a northeast-southwest direction, or nearly parallel to the general trend of the range. The elevation of its snow surface averages about 5,000 feet, and it is bordered by the highest and most rugged mountains in this portion of the Coast range, some of the peaks jutting up through snow-fields to elevations of over 8,000 feet; Mt. Otter, the highest, attaining an altitude of 8,800 feet. Through breaks in the bordering ranges the accumulated snow, compressed into ice, pours westward towards the Pacific and eastward towards the Nass in a series of large glaciers, soon changing as they descend into roaring torrents. The Coast range is singular

in having its watershed and highest mountains in this altitude along its western margin. To the east the mountains decrease gradually in height to elevations of from 4,000-5,000 feet, while to the west the surface drops quickly down to the level of the Nass valley.

In descending Nelson glacier and creek the rough topography of the highest portion of the Coast range is replaced in a few miles by the even contours and comparatively low levels of the broken plateau country bordering the Nass.

The Nelson glacier terminates at an elevation of 1,950 feet and the large stream issuing from it unites with Porter, Willoughby, and other streams to form White river, which empties into the Nass a few miles below the outlet of Meziadem lake.

From Nelson creek a ridge 5,520 feet high was crossed to Mr. Porter's camp on Porter creek, one of the objective points of the trip. This stream, like practically all the large streams descending the east slope of the Coast range in this neighbourhood, heads in a large glacier. A pass from the Porter glacier to the snow valley, previously described, affords a shorter route from Bitter creek to Porter creek than that followed and is used in winter and spring. Later in the season the glacier, which is very steep, becomes badly crevassed and is more dangerous than the longer and less broken Nelson glacier.

GEOLOGY.

Few rock exposures were examined along the route traversed, as the way led for most of the distance along snow-fields and glaciers. Those seen show that the lofty Cambria range and the succeeding one on the east, the marginal range of the Coast mountains, consist largely of the massive, and medium and coarse fragmental greenstones of the Bear River formation. An area of limestones and slates, only seen at a distance, occurs in the angle above the junction of the Nelson glacier with a branch from the northwest. The relationship of these to the greenstones was not ascertained. They may represent a highly calcareous portion of the Bitter Creek formation, which contains considerable limestone in places, or an older formation.

The greenstones of the Bear River formation are replaced along the eastern base of the Coast range by dark shales alternating, in places, with greyish and greenish feldspathic sandstones in bands up to 20 feet or more in thickness. These rocks are referred to the Nass formation. They overlie the Bear River greenstones, resting on them, as a rule, at angles of about 45°. The dip is to the east, and as shown in the partially scarped sides of the plateau-like ridges extending eastwards from the

Coast range between the valley, decreases going eastward to less than 25° in places. The rocks of the Nass formation are not highly altered, except in places near the contact with the Bear River greenstones, are seldom cleaved, and look favourable for fossils, but none were found in the sections examined. They look young, but are probably pre-Cretaceous in age at least, as they are cut by granite dykes and bosses presumably belonging to the period of the Coast Range batholith. The contact between the Nass argillites and sandstones and the Bear River greenstones, where it crosses Nelson, Porter, and Willoughby creeks, is very even and suggests faulting. Farther to the north the Nass rocks extend westward into the Coast range, and are exposed, lying in a nearly horizontal position in the upper portion of several mountains, Strohn creek, and Upper Bear river.

MINERAL CLAIMS AND PROSPECTS.

A wide zone, generally reddened by the surface oxidation of iron pyrites, occurs along the contact of the Nass argillites with the Bear River greenstones. A large number of claims have been staked on this zone, but up to the present little work has been done and no large body of pay ore discovered. The district, while only a few miles from Bear river, is difficult to reach, and all supplies have to be packed in either from Bitter creek, over dangerous glaciers and soft snow-fields, or from the head of Bear river, following a rough foot trail down Strohn creek to Meziadem lake, then southward for many miles across a ridgy woody district practically destitute of trails. No effective work can be done until better communication is established and the cost of supplies greatly reduced.

Notwithstanding the adverse conditions, some development work has been done on the Bullion claim, staked by Mr. Porter and owned by Mr. James Mowat. The showing on this claim is situated on the hillside, north of the foot of the Porter Creek glacier, at an elevation of 500 feet above the valley, and consists of a fissured and partly silicified zone in the argillites of the Nass formation. The zone is about 7 feet wide, has a northwesterly strike, and dips to the northeast at an angle of 70°. Along the foot-wall, as shown in a short tunnel, is a layer of quartz interbanded with argillites from 1 to 2 feet wide. The quartz is copper-stained in places and contains some pyrite, galena, and zinc blende. Samples of the mineralized quartz are reported to have yielded high values in gold and silver, but a specimen collected by the writer was disappointing, as it showed only traces of these metals. This result may possibly be due to an irregular distribution of the precious

metals along the lead. The fissured zone is concealed above the short tunnel and its length is not known.

The Bear River greenstones, near their contact with the Nass argillites, are heavily impregnated with iron pyrites in places, but so far no workable deposit of valuable minerals has been found.

PLACER DEPOSITS.

From Porter creek a ridge rising about 2,000 feet above the valley bottom was crossed to Willoughby creek, on which a number of placer claims have been staked.

Willoughby creek issues from a broken, branching glacier, terminating at an elevation of approximately 2,300 feet, and is a large, rapid stream usually from 30 to 60 feet across, with an average grade of 225 feet per mile. A large branch from the south joins it 3½ miles from the glacier. The valley for 1½ miles below the glacier is wide and bottomed with gravel flats. Below that it narrows in, and in places is confined in rock canyons often bordered by narrow benches.

Willoughby camp is situated about 4 miles from the foot of the glacier. The creek here has cut a shallow box canyon through the shales and tuffs of the Nass formation. A rock terrace on the left bank, about 200 feet wide and 20 feet above the water-level, is covered by 25 feet of coarse gravel.

Some coarse gold is reported to have been found in a bar in the canyon. No work had been done on the bar up to the time of my visit, owing to the continual high water, and it will evidently be difficult to work at any time, as the stream is large, rapid, and its channel filled with boulders. A tunnel has been driven part way across the terrace in the hope of finding a pay channel at that level, but so far without success.

A number of claims have been staked on Willoughby creek above and below Willoughby's camp, on Little White river, and on Little Pat creek, a small foothill stream, but no effective work has been done on any of them.

Some gold occurs on all the streams issuing from the mountains along this portion of the Coast range. Moderately fine, flaky, but still rough gold in small quantities was panned out on Nelson creek, close to the foot of the glacier, and at other points. It is quite possible, although not yet proved, that concentrations may occur in the lower reaches of some of the streams, but unless these prove to be very rich the cost of working them, unless situated above the water-level, would be prohibitive. The streams are all large, are practically continuous rapids throughout, and, as they head in glaciers, high water lasts until late in the season.

Bench gravels occur in Willoughby creek and other places, but the deposits seen were all small.

The creeks staked as placer ground traverse the shales and sandstones of the Nass formation. These rocks, away from the mountains, contain few quartz veins, and the stream gold is probably mostly derived from the greenstones and associated rocks of the Bear River formation in which all the large streams head. No evidence of an old channel crossing the district independently of the present drainage system, firmly believed in by some of the miners, was observed. The bench gravels seen all belong to former higher levels of the present streams.

RETURN ROUTE VIA STROHN CREEK.

The return trip to Bear river was made by Meziadem lake and Strohn creek. Little White river, formed by the junction of Porter and Nelson creeks, has been bridged by the Provincial government a few miles above the mouth of Willoughby creek, and from this point a foot trail has been blazed, but very imperfectly cut out, across the wide wooded ridge separating Nelson from Strohn creek, the next large stream to the north. The ridge, where crossed, has an elevation of approximately 2,700 feet.

Strohn creek has recently acquired importance as a possible route to the Groundhog anthracite basin, at the head-waters of the Skeena, Nass, and Stikine rivers. It heads with Bear river, in a low glacier-covered pass, and flows eastward to Meziadem lake, the latter emptying by a short outlet into the Nass river. Strohn Creek valley has an estimated length of 9 miles, and a grade of approximately 100 feet to the mile. The valley is flat-bottomed, usually half a mile or more in width, and offers no especial difficulty for railway construction.

The glacier at the summit heads in the high mountains to the south, and after reaching the pass alters its course and separates into two short branches, one flowing to the west down Bear river and the other to the east down Strohn creek. The combined length of the two branches is about 1½ miles. This portion of the route would have to be tunnelled. The Strohn creek, or easterly branch of the glacier, terminates at an elevation of approximately 1,540 feet and the Bear River branch at an elevation of 1,370, while the ice-covered summit, where crossed, has an elevation of 2,270 feet, measured by the aneroid.

Bear River valley, from the foot of the glacier at its head to its junction with American creek, the present terminus of the railway, has a length of about 9 miles. It is flat-bottomed

along most of its course, but is narrower than Strohn Creek valley, and along one stretch, about three-fourths of a mile in length, contracts into a canyon. The grade averages about 100 feet to the mile. The bordering mountains are steep and some trouble would probably be experienced from snow slides.

The total length of a railway from the mouth of American creek to the Nass, following Bear river, Strohn creek, and Meziadem lake, would be approximately 32 miles. A tunnel 1½ miles in length would be necessary at the summit, and possibly a short one at the Bear River canyon. A railway to the same point from Nasoga bay, following the valley of the Nass, would have a length of at least 110 miles.

GEOLOGY.

The ridge crossed from Little White river to Strohn creek, as shown by occasional exposures, consists of the shales and sandstones of the Nass formation. The same rocks outcrop at points along Meziadem lake and in the ridges and mountains bordering Strohn Creek valley for a distance of about 5 miles above the lake. They are cut at one point north of the valley by a large granite stock, only seen at a distance. They dip to the east and approaching the mountains become harder and more altered. Four miles from the summit they are underlain and replaced by the greenstones, here largely volcanic fragmentals, of the Bear River formation. The contact between the two formations is concealed in the valley, but is plainly traceable, running a few degrees west of north, in the mountains bordering the valley.

No mineral occurrences of importance are reported along Strohn Creek valley.

PART IV.

OBSERVATORY INLET

BY

R. G. McConnell.

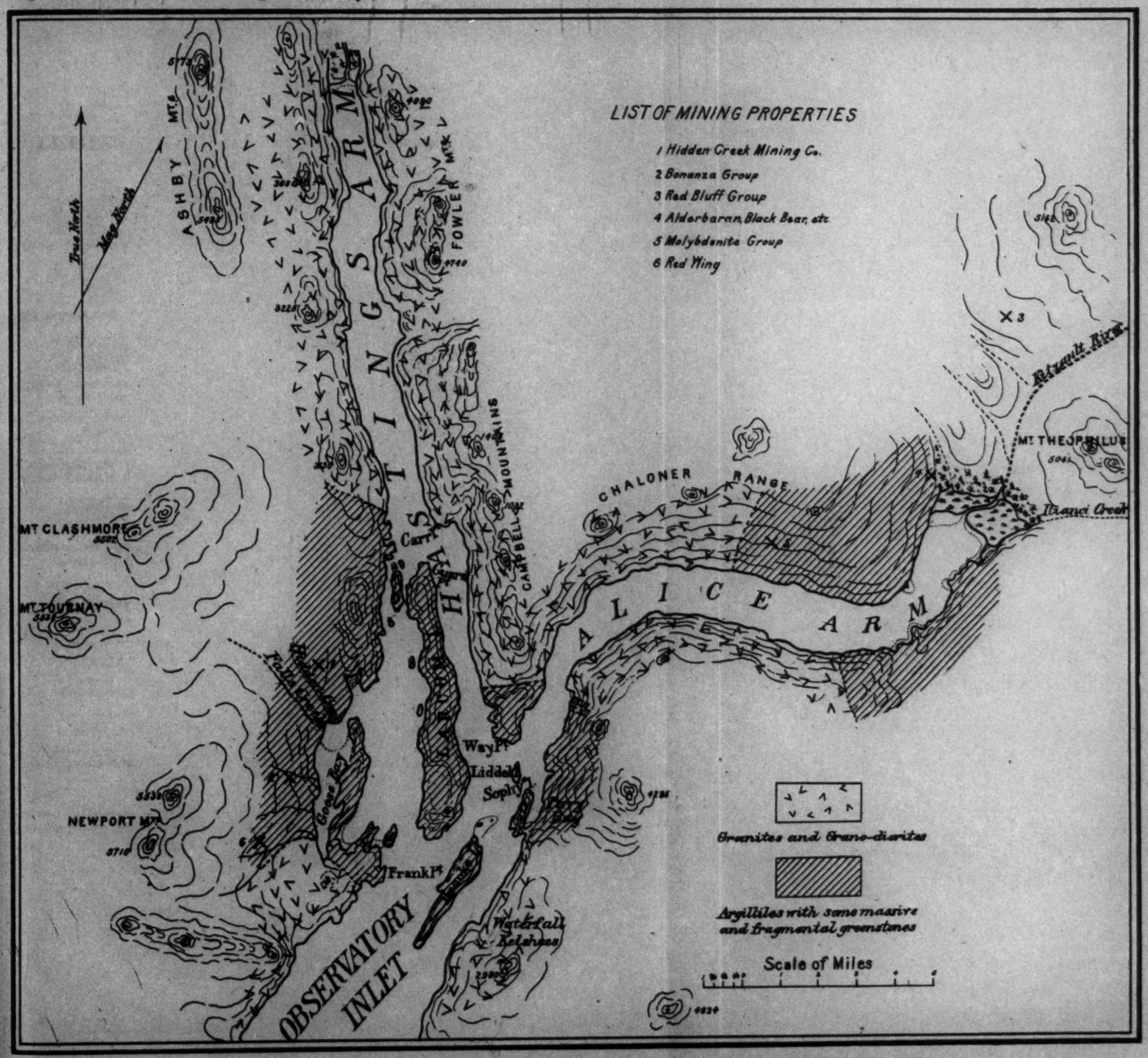
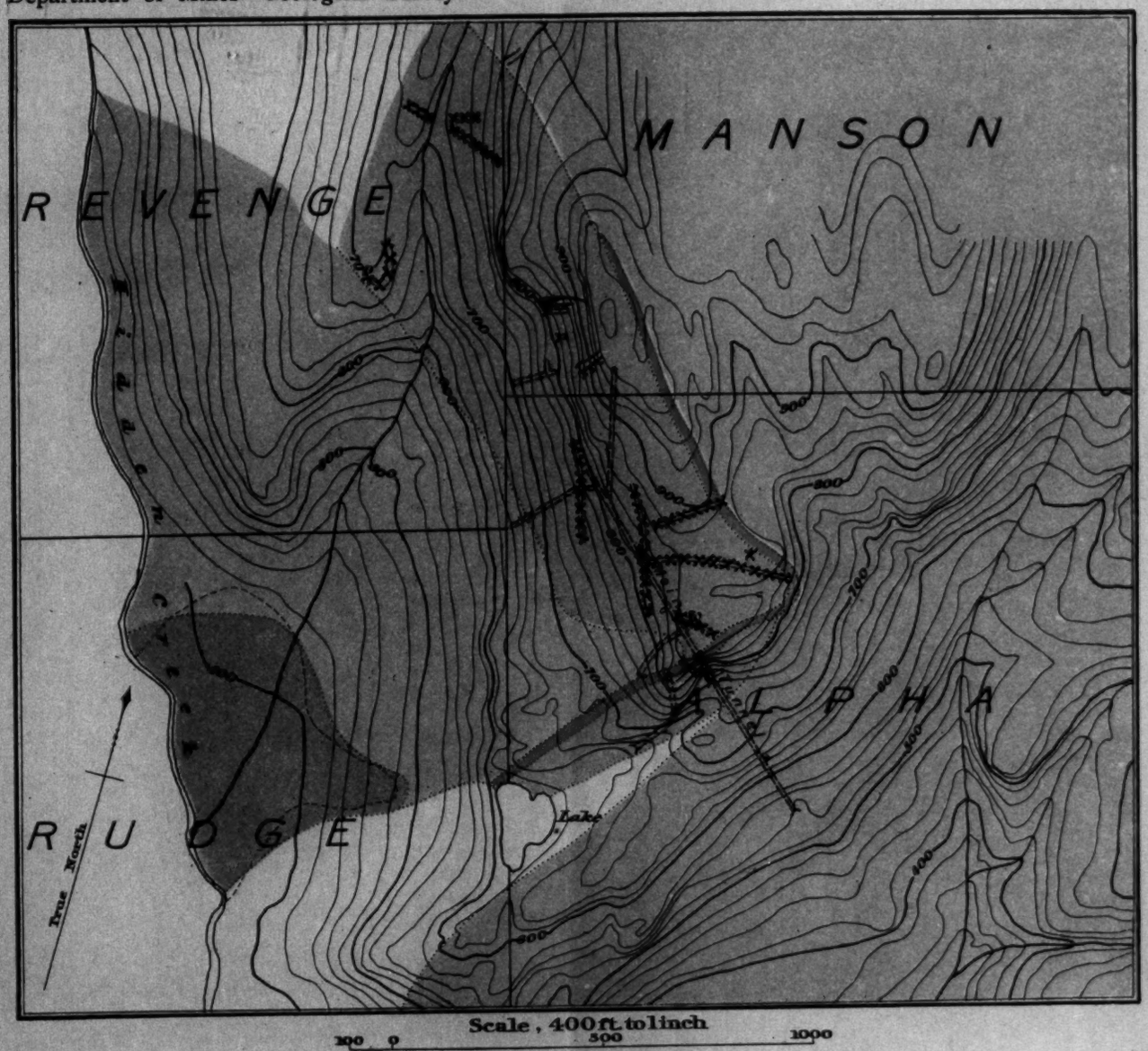


Diagram of portion of Observatory Inlet, B.C.; Geology by R. G. McConnell, 1911.

To accompany Summary Report, 1911

Department of Mines—Geological Survey.



LEGEND

- Goose Bay argillite
- Mineralized area
- Quartz and silicified argillite
- Lamprophyric and olivine basalt dikes
- Surface deposit of Limonite

Symbols

- Open cuts
- Underground workings

Topography based on plans and drawings supplied by mine management.

Diagram showing mineral deposits and workings on Alpha and adjacent mining claims, Hidden Creek, Observatory Inlet, British Columbia; Geology by R. G. McConnell, 1911.

To accompany Summary Report, 1911

PART IV.

OBSERVATORY INLET.

INTRODUCTORY.

Observatory inlet parallels the lower portion of Portland canal on the east, and is connected with it by a passage north of Pearce island. Its shorelines are more irregular than those of Portland canal and towards its head it divides into two branches known as Hastings arm and Alice arm. Hastings arm continues in the general northerly direction of the main inlet, while Alice arm bends to the east and like Portland canal cuts through the granitic batholith of the Coast range and penetrates for some distance the argillites and associated rocks which border it on the east.

At the junction of the two arms, the inlet expands in width and contains a number of islands, some of larger size. Larcom island has a length of 7 miles and Brooke island of 3 miles. West of Larcom island is the entrance to Goose bay, an irregular sheet of water 3½ miles in length and from half a mile to a mile in width. The principal known mineral deposits of the inlet are situated in its vicinity.

The inlet is bordered on both sides by mountains in groups and short ranges, except near the head of Alice arm. From this point, a high rough plateau broken by basaltic cliffs extends eastward to the Nass valley. The mountains present, as a rule, steep glacier-worn sides towards the inlet, and range in height from 3,500 to nearly 6,000 feet. Glaciers occur in some of the valleys but are not so large and conspicuous as along Bear river.

The streams entering the inlet are all of moderate size. They include Falls creek, a short stream with numerous falls emptying into Goose bay, the Kitzault and Ilianci at the head of Alice arm, and a branching sediment-laden stream at the head of Hastings arm. Falls creek is utilized to operate the plant at the Hidden Creek mine. It is a steep stream and flows a large volume of water during the greater part of the year, but like all the streams of the district, the supply becomes greatly diminished during the midwinter months.

Observatory inlet has its whole course in the Coast range and the rock section along it consists mostly of granite. A large included mass of argillites associated with greenstones, mostly pyroclastic in origin, occurs at the junction of the two arms, and argillites also occur along the upper part of Alice arm.

GRANITES.—Granites occur along Observatory inlet from Pt. Ramsden, opposite Pearce island, northward to a point near the southern end of Goose bay where they are replaced by argillites and greenstones. The latter are exposed along the shores of the inlet for a distance of 9 miles and are then followed by granites and allied rocks which continue to the head of Hastings arm and for some distance beyond.

Alice arm extends eastward beyond the eastern edge of the Coast Range batholith. The mountains along the lower portion consist of granite, and those bordering the upper portion of argillites interbanded in places with greenish feldspathic beds.

The granites along Alice arm and the lower part of Hastings arm are medium grained, occasionally porphyritic, greyish rocks made up mostly of quartz orthoclase and plagioclase with sparingly distributed biotite. In the upper part of Hastings arm, the grey granite is replaced by a dark coloured, more basic and apparently older variety, feebly schistose in places, and cut near the contact by acid granitic dykes. This rock is very coarse grained in places, has hornblende as the principal dark mineral, and represents a transition phase between the granites and diorites.

ARGILLITES.—An area of dark argillaceous rocks with some greenstones enclosed on all sides by granite occurs at the junction of Alice and Hastings arms. The area has a width along the west shore of Observatory inlet of 9 miles, but narrows to the east. On the east shore, it is barely 2 miles wide and the area appears to wedge out in the bordering mountains. Larcom, Brooke, and other smaller islands near the junction of the two arms, consist of argillites cut by granitic dykes. The area, while not traced through, probably extends westward to Portland canal, as similar rocks somewhat more highly altered occur in the same strike in the vicinity of Maple bay.

The argillites and associated beds are very similar to the rocks of the Bitter Creek series of Bear river, but cannot be definitely correlated with them until the intervening region is more closely examined. The principal variety is a fine-grained sedimentary rock, made up largely of quartz grains with some feldspar, darkened with carbonaceous material. Mica, mostly secondary, is usually present, and in places the argillite passes

into a quartz mica schist. Secondary quartz, pyrite, calcite, and hornblende are also common constituents.

In texture, the argillites vary from a hard, fine-grained, compact rock to a granular one in which the grains are distinctly visible. The colour varies with the texture, becoming lighter with increasing coarseness, and in places, the fine-grained, dark and coarse, greyish more feldspathic varieties alternate in thin bands.

The argillites are seldom, and only over limited areas, cleaved into slates. Usually they occur in rather heavy beds from 1 to 6 inches or more in thickness, and in weathering form a talus of angular fragments.

The associated rocks are greyish limestones and beds and wide bands of greenstone. The limestones are not prominent, and only occur in small beds and bands seldom traceable for any distance. The greenstones largely replace the argillites towards the southern edge of the area. They are granular, mostly fragmental rocks.

The beds of what may be called the Goose Bay argillite area are folded into a number of anticlines and synclines, striking approximately east and west, or parallel to the long axis of the area. The dips as a rule are regular and comparatively low, although in places the strata are steeply tilted and strongly distorted. No faulting on a large scale was observed.

The Goose Bay sedimentary beds occupy a depression in the granitic rocks of the Coast Range batholith, and are cut by numerous acidic dykes genetically connected with it. Various types are represented, including pegmatite, aplite, quartz porphyry, and granitic dykes. A second system of lamprophyric and basaltic dykes, younger and more basic in character than those connected with the granitic intrusion, is also prominent. The dykes of this system are later than the mineralization of the region.

Dark, sedimentary rocks very similar to those in the Goose Bay area occur along the upper part of Alice arm, east of the main granite area. They consist mostly of fine-grained, dark, slaty rocks often in heavy beds, with coarser feldspathic bands some of which hold small angular fragments. Farther north along the Kitzault valley, in the vicinity of the Red Bluff group of claims, the dark sedimentary rocks are largely replaced by fine and medium grained greenish fragmental rocks tufaceous in character. These rocks include dark argillaceous bands and are much less altered than those in the vicinity of the granite. Their relation to the latter was not ascertained, as in the course travelled along the valley the connecting section is concealed.

No fossils were collected and no evidence in regard to the age of the sedimentary rocks was obtained, other than that they

are cut by and are, therefore, older than the Coast Range granitic batholith usually referred to late Jurassic or early Cretaceous. The argillites are often highly altered locally, in places, passing into mica schists, but this is attributed to the effects of the great granitic invasion and affords no proof of extreme age. It is probable that none of the sediments are older than the Carboniferous.

MINERAL DEPOSITS.

The mineral deposits of Observatory inlet consist of quartz veins carrying values in silver and lead and in one case in molybdenum, and of what can only be described as mineralized areas carrying low values in copper. The latter will be described first.

MINERALIZED AREAS CARRYING LOW VALUES IN COPPER.

Hidden Creek Copper Company.

The claims controlled by this Company were staked about ten years ago and a considerable amount of surface and underground work was done on them by the Hidden Creek Copper Company under the direction of Mr. M. K. Rogers. Recently the claims were bonded to the Granby Consolidated Mining, Smelting, and Power Company operating at Phoenix, B.C., and a diamond drill test of the property by this Company proved so satisfactory that the bond was taken up and preparations are now being made to work it on an extensive scale.

The thanks of the writer are due to Mr. O. B. Smith, General Mines Superintendent of the Granby Company, and Mr. MacDonald, local manager of the Hidden Creek mine, for permission to examine the workings, for information, and for other courtesies.

Situation.—The claims are staked on the summit and sides of a hill 920 feet high, enclosed between two branches of Hidden creek, and situated 8,500 feet north of Goose bay, near its outlet into Observatory inlet. A good wagon road, planked where necessary, about 2 miles in length, has been built from the portal of the main tunnel to a wharf at Anyox on Goose bay, the shipping port of the mine, and a tramway, partly gravity and partly traction, to the same point, was commenced some years ago but never completed.

Rocks.—The rocks in the vicinity of the mine consist of dark and dark grey argillites with occasional light coloured, coarse-grained feldspathic beds and rarely some limestone.

Beds and bands of greenstones, probably largely of pyroclastic origin, occur with the argillites and constitutes the country rock of the second ore body. Both argillites and greenstones are always more or less altered, and in places pass into mica, quartz mica, and chloritic schists. The bedding is coarse, and while a strong cleavage is developed in spots, the bedding planes over most of the area constitute the principal partings. The beds have been compressed into several folds, and, in places, dip steeply, but are seldom, in the section examined, overturned, and no large faults were observed. The strike, while generally east and west, shows considerable variation in places.

The argillites and associated rocks are exposed over an area about 9 miles wide, where cut by Observatory inlet. They are surrounded by the granite rocks of the Coast range and are considered to be an undestroyed and deeply sunken portion of the old roof of the Coast Range batholith. The basin they occupy is of great depth, as the sedimentary rocks of the inclusion are exposed from base to summit of mountains over 5,000 feet in height, and they must extend for a considerable depth below the present surface.

The argillites are cut by numerous dykes, one set being older than the mineralization of the region and genetically connected with the enclosing granitic rocks. These vary widely in character and include granitic, dioritic, quartz porphyry, aplitic and pegmatitic types. In addition to these, a second widely distributed set occurs, the members of which were intruded after the mineralization of the region. These are fine to medium grained basic dykes often of a lamprophyric character. Thin sections from examples cutting Mammoth bluff showed laths and occasional phenocrysts of feldspar, mostly plagioclase, with abundant brown hornblende in long prisms and occasional plates of mica. Rounded irregularly bounded quartz grains, possibly of foreign origin, are also present, and large calcite areas probably representing original olivine are of frequent occurrence. A second type obtained from a dyke crossing the main tunnel of the Hidden Creek mine between the two ore bodies, contained large olivine and augite phenocrysts in a fine-grained hornblende-feldspar base and is classed as an olivine basalt. A third type, represented by a dyke crossing the Redwing, consists mainly of hornblende and plagioclase and possesses a well marked ophitic structure.

The later dykes may be connected with a basaltic flow which caps the hills south of Alice arm. They do not appear to affect in any way the ore bodies they cut.

WORKINGS.—A large amount of surface and underground work has been done on the Hidden Creek mine. The mineralized area is very large and was first outlined roughly by long

trenches running in various directions. Subsequently a working tunnel was started below what is known as Cabin bluff at an elevation of 530 feet, and has been driven straight in to the hill in a northwesterly direction for 950 feet. A drift to the left from the main tunnel, starting 85 feet from the face, has been carried in for a distance of 300 feet, and several shorter drifts from points along the main tunnel serve to explore the ground bordering it.

Besides the main working tunnel and its branches, a number of shorter tunnels have been driven at various heights into the iron-stained slopes of Cabin and Mammoth cliffs. One of these, commencing in a depression at the foot of Cabin bluff, is connected by an upraise with the main tunnel.

In addition to the numerous trenches and tunnels, the mineralized area has been further extensively explored with the diamond drill by the Granby Company, the present owners of the property. A number of long bore-holes, starting from various points along the main tunnel and from the surface, have been drilled and have yielded valuable information in regard to the general character of the deposit.

Size and General Character of the Deposits.—The mineralized area, as shown by the various surface and underground workings, is of great extent although it has not as yet been fully defined, both ends being still unknown. In shape it forms a right angle. The smaller arm, known as the first ore body, has a northeasterly strike and dips to the northwest. It has been traced from the main tunnel in a southwesterly direction for over 600 feet, the width averaging about 160 feet or including a siliceous band which borders it on the northwest, of nearly 200 feet. The longer arm holding the second ore body has been traced in a northwesterly direction for a distance of 1,500 feet with an average width of about 400 feet. The deposit has been proved by a bore-hole to a depth of 514 feet below the main tunnel or approximately 900 feet below the surface outcrops on the hill.

While only a portion of the large area described contains valuable minerals in sufficient quantities to constitute commercial ores, the original rocks are everywhere either completely altered into greenish or less commonly brownish micaceous schists or replaced by quartz and iron and copper sulphides. The transition from the dark, slightly altered argillites and greenstones which constitute the country rocks, to ore is usually fairly abrupt, often occurring in a few inches.

A conspicuous feature of the deposit is the presence of a zone of whitish quartz schists, practically strongly silicified argillites, traceable part way around it. This siliceous zone forms the northwestern boundary of the southwestern or smaller arm, crosses the deposit, then bending at right angles continues

to the northwest as the northwestern boundary of the larger arm. It was not observed on the southwest border of the larger arm or the southeastern border of the smaller one.

The rocks in the siliceous zone vary in the amount of silicification undergone. In most places they are nearly pure quartz schists, but occasionally the zone consists of alternating dark and white bands. The width of the zone ranges from 30 to 60 feet and more. The dip where it skirts the smaller arm and crosses the deposit is to the northwest, but after bending to the northwest the dip, as shown by the bore-holes, changes to the northeast. It thus forms the hanging wall of both arms.

MINERALOGY.—The metallic minerals present consist mainly of iron pyrite, some of it cupriferous, pyrrhotite, and subordinate quantities of chalcopyrite. A little bornite, evidently secondary, was found at one point. The principal non-metallic constituents are quartz, some calcite, a greenish micaceous schist, probably largely chloritic, some brownish micaceous schists, and occasionally some hornblende.

Pyrite is the most abundant metallic mineral present. It usually occurs in a granular condition, and in places near the surface breaks down into an iron sand. It is always associated with more or less quartz and large areas consist of pyrite grains separated by a thin siliceous matrix. It also occurs in grains and small bunches distributed through the secondary schists. Its distribution through the mineralized area is irregular, some portions containing only a small percentage, while others consist almost entirely of sulphides and quartz. The main tunnel, started some distance down the slope from the mineralized area to gain depth, passes through 380 feet of argillites, all somewhat altered and containing occasional grains and small bunches of pyrite, then through a pyritic zone 200 feet wide, becoming very siliceous towards the northwest border, then through a greenish schistose zone with some quartz and pyrite 240 feet wide, beyond which is a second pyritic area which continues to the end of the tunnel 120 feet. A drift to the left from a point near the end of the tunnel running about north for 300 feet, shows the continuation of the pyritic area for that distance, the breast being in granular sulphides mostly pyrite, embedded in a siliceous matrix. A drift to the left passes through sulphides and quartz for 100 feet, then through greenish chloritic schists only slightly mineralized for 120 feet.

The comparatively barren interval separating the two pyritic areas in the tunnel is not apparent on the surface, some of the ground overlying the lean portion being well mineralized with sulphides.

Pyrrhotite, while much less abundant than pyrite, is common throughout the greater part of the mineralized area. It

occurs intermingled with the pyrite and also forming comparatively large masses usually specked with chalcopyrite.

Chalcopyrite in grains, small aggregates of grains, and in thin layers usually accompanies the iron sulphides where the replacement is complete or nearly so, and also occurs in small quantities scattered through portions of the schistose areas. The proportion present, while variable, is always small and in certain areas seems to be absent altogether. The chalcopyrite is associated so intimately with the iron sulphides that there is little doubt that both are the products of the same period of deposition.

Bornite was found at one point, but only as a surface alteration mineral, and it does not occur so far as known as a primary mineral of the deposit.

Among the non-metallic minerals, quartz is the most prominent. A wide siliceous zone crosses and bounds portions of the mineralized area, and the large sulphide areas are all more or less siliceous. Calcite occurs occasionally but is not prominent. Portions of the area included in the mineralized zone on the accompanying map consist of greenish micaceous schists often highly siliceous. These carry significant quantities of sulphides in some places and are nearly barren in others.

Ores.—The iron sulphides in the Hidden Creek mine carry very low values in the precious metals. Out of a number of samples assayed in the laboratory of the Mines Department one showed 0·02 ounce gold to the ton, one 1·65 ounce silver, and the rest only traces. The commercial value of the deposit must, therefore, depend mainly on the copper content. Chalcopyrite usually accompanies the iron sulphides, but in variable amounts. Some areas are nearly barren, while others contain sufficient quantities to constitute a low grade copper ore, that is ore carrying up to 3 per cent copper and over limited areas an even higher percentage.

The most important body of commercial ore so far outlined in the boring operations of the Company, occurs southeast of the siliceous zone previously described as bordering the shorter arm of the deposit on the northwest and continuing along the larger arm. The siliceous zone is fringed by a band of ore usually from 20 to 25 feet in width and already traced for a distance of nearly 1,400 feet. A vertical bore-hole from the main tunnel apparently proves it to a depth of 514 feet below that level and it extends to the surface above, a variable distance, depending on the contours of the country, but probably averaging about 200 feet. The huge tonnage expected from this ore body will undoubtedly be greatly supplemented from other portions of the mineralized area. Workable ores are known to occur at a number of points, but the definition of their extent and quality awaits further exploration.

ORIGIN OF THE DEPOSITS.—The mineralized area at the Hidden Creek mine occurs in a large predominantly argillaceous area surrounded and doubtless underlaid, although at a considerable depth, by granitoid rocks, and cut by dykes and stocks belonging to the same period of igneous intrusion. The strata were irregularly compressed and folded at the time of the invasion and the deposit probably occupies an area more than ordinarily crushed and fractured, although this has been masked by subsequent alteration and deposition and is not apparent. A wide broken zone, rather than a single fissure, is conceived to have afforded the means by which heated siliceous waters carrying iron and copper sulphides in solution ascended from the underlying batholith, altering the country rock in their upward passage and replacing them with silica and sulphides as the pressure and temperature conditions became less severe.

An origin of this kind would ally the deposit genetically with the loosely defined contact metamorphic group, although the ordinary contact metamorphic minerals, including the iron oxides, were not observed, and are either absent altogether or present only in very small quantities.

Deposits of the contact metamorphic group, that is, deposits situated on or near the contact of igneous masses with sedimentaries and formed by ore-bearing solutions, either aqueous or gaseous, emanating from the cooling intrusive, vary widely in character. Ordinarily they are described as bunchy, irregular masses, made up mostly of iron oxides, and iron, copper, lead, and zinc sulphides, in a gangue of secondary silicates, mostly garnet, epidote, augite, and tremolite. An examination of numerous occurrences at various points along the west coast indicates, however, that neither shape nor the presence of any or the majority of the compounds mentioned are essential features. The shape is dependent on the channel followed, and in a broken region perfect vein forms produced by the complete replacement of the country between parallel fissures are not uncommon. The constituents are also dependent on the character of the parent intrusive, on conditions of deposits, and possibly on the aqueous or gaseous character of the emanations, and gradations occur from masses of pure or nearly pure magnetite to others made up largely of tremolite and iron and copper sulphides, and in some instances of quartz and sulphides. The present classification, based only on a broad genetic relationship, is far from satisfactory. The name of the group is also misleading, as it included deposits far removed from actual contacts.

EQUIPMENT.—Work on the Hidden Creek mine up to the present has been altogether of an exploratory character, but plans for working and equipping it on a scale commensurate with

its importance and for transportation of the ores to the beach are now being formulated. A smelter will probably be erected to treat the ores, but the site of this was not decided on at the time of my examination, or at least was not announced. The present equipment includes a power plant situated on Falls creek and operated by water furnished by that stream, and a compressor and diamond drill plant.

Bonanza Group.

This group is situated about three-fourths of a mile up Bonanza creek, a small stream emptying into Goose bay about 2 miles below its mouth. Bonanza creek is a rapid stream about 20 feet wide, confined in a deep, narrow valley terminating below in a rock canyon 20 to 30 feet deep, excavated since the glacial period.

The Bonanza group of claims, six in number, were the first claims staked in the district, and were explored to some extent by Mr. M. R. Rogers before the discovery of the Hidden Creek group. Very little work has been done on them in recent years.

The general character of the deposit on which the claims are staked is similar to that of the Hidden Creek group. The country rock is a dark, somewhat altered, argillite cut by pegmatite and dioritic dykes, before it was mineralized, and by a later set of basic dykes after it was mineralized. The argillites are altered over a wide area into biotite and chloritic schists, some of it quite coarse, holding variable quantities of pyrite, pyrrhotite, and in places chalcopyrite. The sulphides are accompanied by some quartz, but this mineral is much less abundant than in the Hidden Creek mine. The altered and mineralized area has a width of over 500 feet, and is opened up by short tunnels for a distance of 600 feet along its strike.

The workings consist of 3 tunnels, one over a hundred feet in length, north of Bonanza creek, near the creek level, and two tunnels and some surface work on the south side. The most westerly of the tunnels north of the creek cuts 10 feet of granular pyrite near its mouth, beyond which are micaceous schists holding only a small percentage of sulphides. Little copper is present. A sample of the granular pyrite gave on assay 0·48 per cent copper, 1·25 ounce silver to the ton, and traces of gold. Some pyrrhotite holding specks of copper occurs in the middle tunnel. The east tunnel passes through micaceous schists sparingly mineralized with pyrite.

The two tunnels south of the creek expose schists holding pyrite in scattered grains and bunches, and occasionally some chalcopyrite. Some good looking chalcopyrite ore is exposed

in a cut near the creek, but further exploration is needed to determine whether it occurs in workable quantities or not.

The Bonanza ground looks favourable enough to warrant a diamond drill exploration such as that in progress with such favourable results in the Hidden Creek property. The area of altered schists carrying iron and occasionally copper sulphides is very large and the present workings cover only a small portion of it.

A large quartz vein, fully 10 feet wide in places, occurs on the North Star claim, one of the Bonanza group. It holds some pyrite and chalcopyrite. A sample assayed yielded only 0·48 per cent copper and 0·20 ounce silver to the ton. A number of large quartz veins occur around Goose bay, most of which seem to be barren or nearly so.

Redwing.

The Redwing, staked in 1909 by Joseph McGrath, is situated about 2 miles up Glacier creek at an elevation of 1,820 feet above sea-level. Glacier creek is a short rapid stream issuing from a glacier which fills the upper part of its valley, and emptying into Goose bay near its lower end.

The country rock in the vicinity of the claim is an altered silicified greenstone, passing in places into a schist, lying between the argillites and the granite. Granite occurs a short distance to the south, and a wide dyke or spur crosses the valley at one point.

The claim is staked on a conspicuous oxidized zone in the greenstone running up the northern wall of the valley. The zone has a width of over 50 feet in places, contains some quartz stringers, and is paralleled on the east for some distance by a strong quartz lead. A basic dyke, made up largely of hornblende and fresh plagioclase and showing a diabase structure, crosses it at one point.

The mineralization is similar to that of the other occurrences described, consisting of iron sulphides with some irregularly distributed chalcopyrite. The only development work done consists of a tunnel 25 feet long, driven into the face of the cliff near the centre of the oxidized zone. This passes through the basic dyke mentioned above, then through 6 feet of nearly solid iron with some copper sulphides, the latter in grains and fair sized bunches, then through micaceous schists sparingly mineralized. Chalcopyrite occurs both in the tunnel and at other points in sufficient quantities to constitute a good copper ore, but more development work is needed to prove quantity. Assays of the sulphides are stated to show some values in the precious metals.

Red Bluff Group.

Looking up the wide valley of the Kitzault river from the head of Alice arm, a red patch shows prominently on the face of a mountain north of the river, distant about 4½ miles. A number of claims have been staked on the red area and grouped together under the name of the Red Bluff group.

A short visit to the showing was made in company with Mr. Young, one of the owners, but as little development work has been done, observation was limited to the general surface features. A rough trail leading up the valley of the Kitzault for some distance, then up a tributary stream from the north, has been brushed out to the foot of the red bluff.

The rocks in the neighbourhood of the showing consist mostly of fine and medium-textured, greenish, tufaceous sandstones alternating in places with bands of finer grained, dark argillaceous rocks. The tufaceous sandstones occur in wide, practically massive bands, showing little stratification. They are not much altered and consist mainly of rounded and angular feldspar grains, some quartz, and fragments of glass and volcanic rocks.

The mineralized area is very large, fully a thousand feet in width, and traceable for a long distance up the steep slopes of the mountain. The rocks are fractured and the pyrite oxidized to a greater depth than usual, and no large mass of sulphides is exposed on the surface. Copper carbonates in small quantities occur at a number of points, and a specimen consisting mostly of white pyrite in a siliceous gangue contained small specks of bornite. Some pyrargyrite in small grains was also found with pyrite in one exposure. This mineral does not occur, or at least has not been found, in the other large iron croppings of the district. A crust deposited by a spring bubbling up near the centre of the deposit was determined by Mr. R. A. A. Johnston as allophane, a hydrous silicate of aluminium.

The economic importance of this large pyritized area is uncertain. It contains some copper, and while the small amount of surface work which has been done has not exposed it in commercial quantities, the prospects certainly warrant further exploration. The presence of the rich silver mineral pyrargyrite, even in small quantities, is important.

QUARTZ VEINS.

Aldebaran, Black Bear, Etc.

Quartz veins rich in silver occur on a group of claims, including the Aldebaran and Black Bear, located three-fourths

of a mile north of the head of Alice arm, on the lower slopes of the mountains bordering the valley on the west. They were located in 1906, and the controlling interest is owned by Mr. Frank Roundy.

The principal showing is on the Aldebaran and consists of stringers of quartz cutting the argillites for a width of about 6 feet. The central vein has a width of 6-8 inches and a drift has been started on it. It is well mineralized, while the bordering quartz stringers are nearly barren. The strike is northwesterly, and the dip to the southeast at an angle of 45°. The minerals present consist of pyrargyrite or ruby silver in considerable quantities, argentiferous galena, pyrite, chalcopyrite, and sphalerite. The vein, where exposed in the short tunnel, runs very high in silver, but has only been followed for a short distance. A small cut 100 feet from the tunnel in the direction of the lead shows a quartz vein 3 feet thick, and quartz also occurs in cuts 250 and 350 feet distant. It is uncertain if the small quartz veins in these cuts represent a continuation of the rich vein at the tunnel or are different veins lying in the same fracture zone. They contain some values but are less highly mineralized, and no pyrargyrite was noted.

Molybdenite Group.

These claims are situated north of Alice arm, about a mile east of the contact of the argillaceous series with the granite of the Coast range, and at an elevation of 1,100-1,400 feet above sea-level. The argillites are associated with some coarse feldspathic beds probably of tufaceous origin, and by pre-granite, altered, greenish dykes.

The showing consists of a series of quartz veins and stringers following a fractured zone striking in a northeasterly direction and traceable for over 1,000 feet. The strike of the veins is parallel to that of the zone as a rule, but occasionally they cross it diagonally. They vary in thickness from a few inches up to 4 feet.

The quartz veins contain molybdenite sometimes in considerable quantities, in scattered flakes, small bunches, and in lines parallel to the sides. Other minerals present in small quantities are iron pyrite, galena, and blende. A strong quartz porphyry dyke which crossed the trend of the lead is slightly mineralized with molybdenite and cut by small quartz stringers.

A specimen of the molybdenite-bearing quartz assayed in the laboratory of the Department of Mines, contained 2·60 per cent of molybdenum and traces of gold and silver. The owners state that fair gold values have been obtained from places along the lead.

Waterfront Claim.

The claim is situated on the north side of Alice arm, about half a mile from its head. It contains a strong quartz lead about 6 feet thick which outcrops near the water level and is said to be traceable in a northwest direction across the claim. It contains grains of iron pyrite, galena, and sphalerite, but is only lightly mineralized. Pyrargyrite is stated to have been obtained from it, but none was seen by the writer.

A galena showing on a branch of Lime creek in the mountains south of Alice arm, and a large iron showing high up, west of Goose bay, were not examined, as at the time of my visit (June 23-July 15, 1911) they were still buried in snow.

MAPLE BAY.

Maple bay is a small indentation in the coast of Portland canal, situated due west from the head of Goose bay, on Observatory inlet. The argillaceous rocks of Goose bay extend westward across the mountain range separating Observatory inlet from Portland canal, and crop out along the shores of the latter in a wide band in the vicinity of Maple bay. They become more altered in their extension westward, and the dark argillites are represented by greyish and dark micaceous schists and the included greenstone bands, both plastic and massive, by chloritic schists.

The schists are cut in places by quartz veins, and one of these was mined on a considerable scale some years ago by the Brown Alaska Company. The vein worked is situated about a mile from the beach in a N.N.E. direction, and at an elevation of 980 feet above it. A road from the beach to the mine was constructed, a wharf built and a number of buildings, including bunkers, erected at the mine and wharf, and a compressor and boiler-house at the beach. All of these are now rapidly going to ruin.

The principal workings consist of a long tunnel measuring roughly 980 feet. The quartz vein was followed for 550 feet. It was then either lost or gave out, as little quartz was noticed in the last 430 feet. The vein strikes a few degrees east of north and dips to the east at an angle of 45°. It consists mostly of quartz with some enclosed schist, and ranges in width from 3 feet to about 12 feet. The principal metallic minerals noted are pyrrhotite, pyrite, and chalcopyrite. The percentage of chalcopyrite varies, and only in places is present in sufficient quantities to constitute an ore. Small values in the precious metals are reported.

Some stoping has been done and the ore shipped to a smelter on Prince of Wales island. The general tenor of the ore was not earned. The mine has been idle for several years.

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CLASSIFIED LIST OF RECENT REPORTS OF GEOLOGICAL SURVEY.

Since 1910, reports issued by the Geological Survey have been called memoirs and have been numbered Memoir 1, Memoir 2, etc. Owing to delays incidental to the publishing of reports and their accompanying maps, not all of the reports have been called memoirs, and the memoirs have not been issued in the order of their assigned numbers, and, therefore, the following list has been prepared to prevent any misconceptions arising on this account.

Memoirs and Reports Published During 1910.

REPORTS.

Report on a geological reconnaissance of the region traversed by the National Transcontinental railway between Lake Nipigon and Clay lake, Ont. By W. H. Collins. No. 1059.

Report on the geological position and characteristics of the oil-shale deposits of Canada. By R. W. Ells. No. 1107.

A reconnaissance across the Mackenzie mountains on the Pelly, Ross, and Gravel rivers, Yukon and North West Territories. By Joseph Keele. No. 1097.

MEMOIRS—GEOLOGICAL SERIES.

Memoir 1. *No. 1, Geological Series.* Geology of the Nipigon basin, Ontario. By Alfred W. G. Wilson.

Memoir 2. *No. 2, Geological Series.* Geology and ore deposits of Hedley Mining district, British Columbia. By Charles Camsell.

Memoir 3. *No. 3, Geological Series.* Palaeoniscid fishes from the Albert shales of New Brunswick. By Lawrence M. Lambe.

Memoir 5. *No. 4, Geological Series.* Preliminary memoir on the Lewes and Nordenskiöld Rivers coal district, Yukon Territory. By D. D. Cairnes.

Memoir 6. *No. 5, Geological Series.* Geology of the Haliburton and Bancroft areas, Province of Ontario. By Frank D. Adams and Alfred E. Barlow.

Memoir 7. *No. 6, Geological Series.* Geology of St. Bruno mountain, Province of Quebec. By John A. Dresser.

MEMOIRS—TOPOGRAPHICAL SERIES.

Memoir 11. *No. 1, Topographical Series.* Triangulation and spirit levelling of Vancouver island, B.C., 1909. By R. H. Chapman.

Memoirs and Reports Published During 1911.

REPORTS.

Report on a traverse through the southern part of the North West Territories, from Lac Seul to Cat lake, in 1902. By Alfred W. G. Wilson. No. 1006.

Report on a part of the North West Territories drained by the Winisk and Upper Attawapiskat rivers. By W. McInnes. No. 1080.

Report on the geology of an area adjoining the east side of Lake Timiskaming. By Morley E. Wilson. No. 1064.

MEMOIRS—GEOLOGICAL SERIES.

Memoir 4. *No. 7, Geological Series.* Geological reconnaissance along the line of the National Transcontinental railway in western Quebec. By W. J. Wilson.

Memoir 8. *No. 8, Geological Series.* The Edmonton coal field, Alberta. By D. B. Dowling.

Memoir 9. *No. 9, Geological Series.* Bighorn coal basin, Alberta. By G. S. Malloch.

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MEMOIRS—BIOLOGICAL SERIES.

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Memoirs Published During 1912.

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Memoir 28. *No. 18, Geological Series.* The geology of Steeprock lake, Ontario. By Andrew C. Lawson. Notes on fossils from limestone of Steeprock lake, Ontario. By Charles D. Walcott.

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MEMOIRS IN PRESS, NOVEMBER 1, 1913.

Memoir 25. *No. 21, Geological Series.* Clay and shale deposits of the western provinces (Part II). By Heinrich Ries and Joseph Keele.

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Memoir 40. *No. 24, Geological Series.* The Archaean geology of Rainy lake. By Andrew C. Lawson.

Memoir 32. *No. 25, Geological Series.* Portions of Portland Canal and Skeena Mining divisions, Skeena district, B.C. By R. G. McConnell.

Memoir 19. *No. 26, Geological Series.* Geology of Mother Lode and Sunset mines, Boundary district, B.C. By O. E. LeRoy.

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Memoir 30. *Geological Series.* Basin of Churchill and Nelson rivers. By W. McInnes.

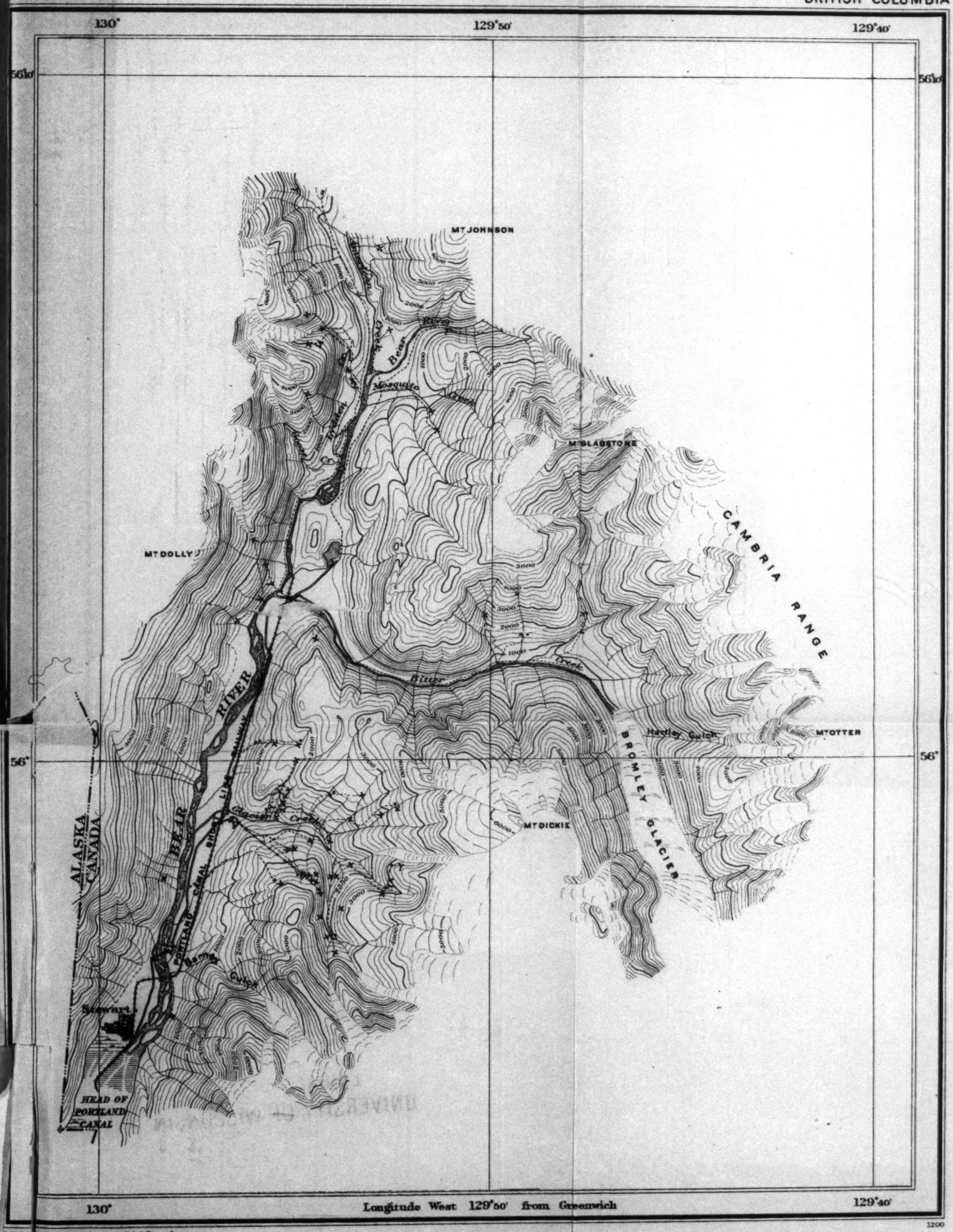
Canada
Department of Mines
GEOLOGICAL SURVEY

HON. W. B. NANTEL, MINISTER; A. P. LOW, DEPUTY MINISTER;
R. W. BROCK, DIRECTOR.

1911

TOPOGRAPHY

BRITISH COLUMBIA



1200

C. O. Senécal, *Geographer and Chief Draughtsman.*
A. McGregor, *Draughtsman.*

LEGEND

Culture

- Streets, roads and buildings
- Trails
- Railways
- Aerial tramways
- Bridges
- Shafts
- Tunnels
- Prospects
- International boundary
- Boundary monuments

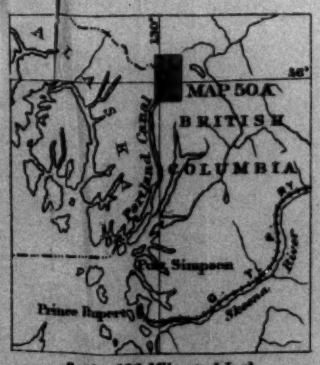
Water

- Rivers and streams
- Glaciers
- Salt marshes
- Tidal flats

Relief

- Contours
  (showing land forms and elevations above sea-level)
  Interval 200 feet

Magnetic Declination about 31°30' East



Scale, 100 Miles to 1 Inch.

MAP 50A

Part of
PORTLAND CANAL MINING AREA
BRITISH COLUMBIA

Scale, 1/125,000

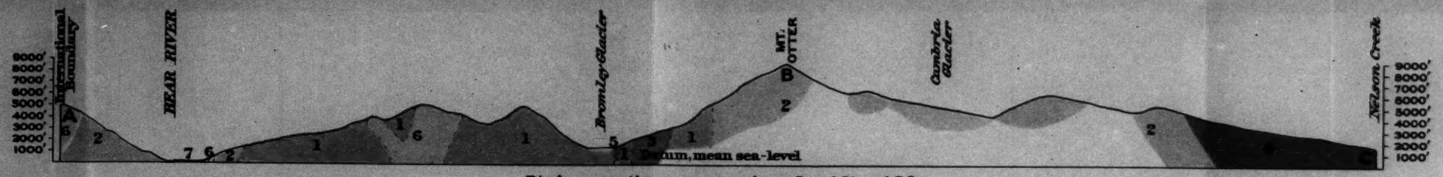
Miles 1 0 1 2 3 4 5

Kilometres 1 0 1 2 3 4 5 6 7

Note. For practical purposes assume
2 MILES TO 1 INCH

TOPOGRAPHY
G. S. MALLOCH 1910

To accompany Memoir N° 32



Diagrammatic cross-section along line ABC

Department of Mines—Geological Survey.

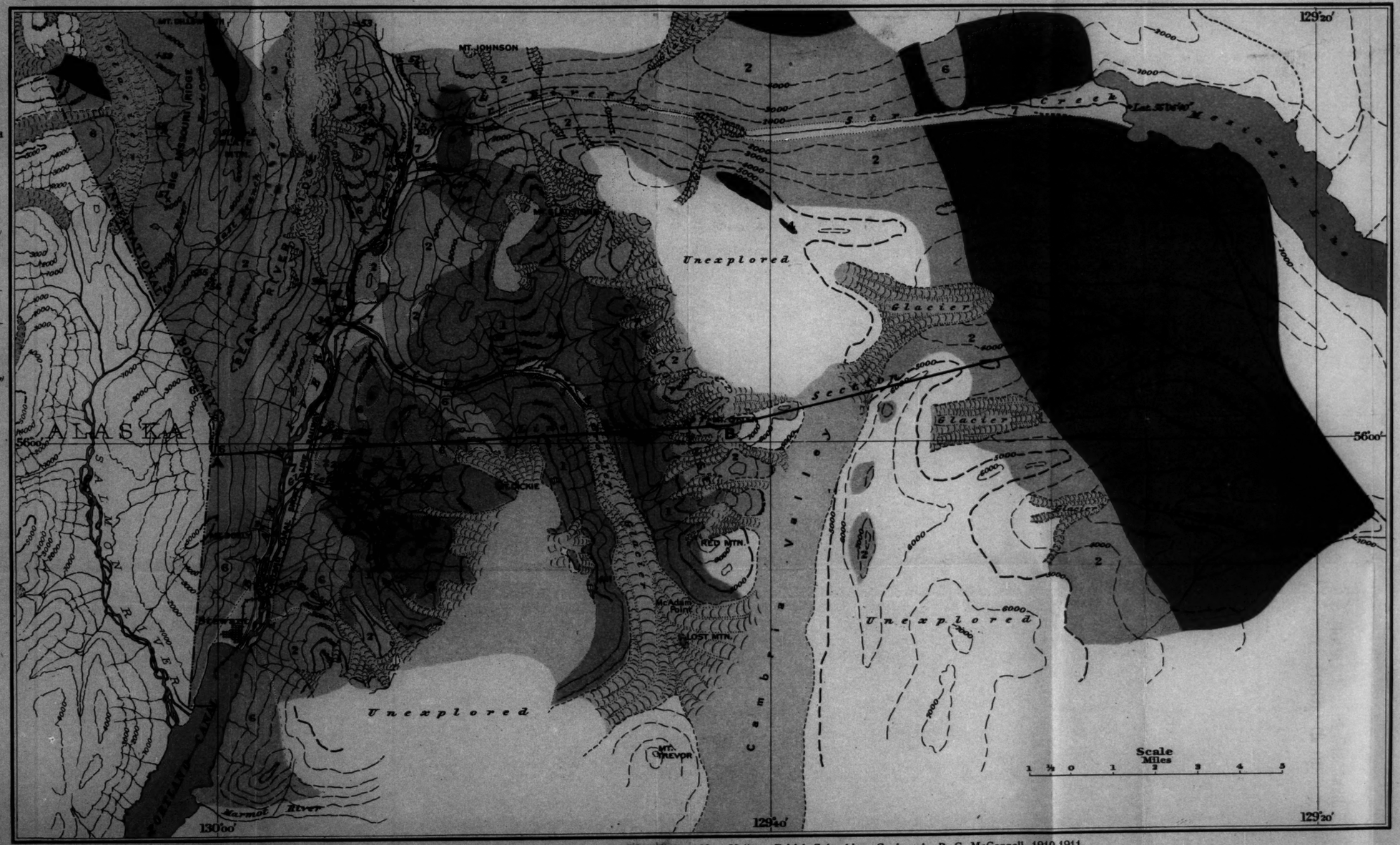
LEGEND

COAST RANGE GRANITIC ROCKS

- 7 — Superficial deposits (alluvial gravel, sand and clay; estuarine deposits of gravel, boulder clay)
- 6 — Granite, granodiorite and quartz porphyry
- 5 — Gabbro
- Nass formation (argillite, tuffaceous sandstone)
- 4 — Augite porphyrite
- 3 — Bear River formation (porphyrite, tuff, breccia, agglomerate, etc.)
- 2 — Bitter Creek formation (argillite, some tuffaceous beds and occasional bands of limestone)
- Snow fields
- Glaciers

Symbols

- Geological boundaries (position defined)
- Geological boundaries (position assumed)
- Roads
- Trails
- Shafts
- Prospects
- Tunnels
- Aerial tramways



TUNNELS (T) and PROSPECTS (P)

Portland Canal District

1 Copper Cliff
2 Franklin
3 Jumbo
4 Chicago No. 1
5 Chicago No. 2
6 Excelsior
7 Matheson Cut
8 Portland Canal Mining Co.
9 " " " "
10 Name not known
11 Gypsy
12 Columbia
13 Evening Sun
14 Silver King
15 Katharine
16 June
17 Name not known
18 " " "
19 " " "
20 O.K.
21 Portland Wonder
22 Stewart Mining and Development Co.
23 Glacier Creek Mining Co.
24 Sunbeam
25 Main Reef
26 Surprise
27 Tyee
28 Silver Bow
29 " " Extension
30 Name not known
31 Keystone
32 Lakeview
33 Gold Bar No. 1
34 Portland Star Mining Co.
35 Mammoth
36 Ben Lomond
37 Dundee
38 Crown Mining Co.
39 Cupron
40 Roosevelt
41 Black Bear Group
42 a L. L. and H. Group
42 Old Chum Group
43 Initial Group
44 Dreadnought Mining Co.
45 Red Cliff Upper Showing
46 " " Long Tunnel
47 Big Casino
48 Montrose
49 Red Cliff Extension
50 Bonanza
51 Ruby No. 2
52 Catchem
53 Mountain Boy
54 Independence

Salmon River Valley

55 Cascade Falls Mining Co.
56 Salmon Bear River Mining Co.
57 Indian Mining Co.
58 Big Missouri
59 Martha Ellen

Nass Valley

60 Bullion Claim
61 Placer Camp
62 " "

Diagram of Portland Canal Mining District, with portions of Salmon and Nass Valleys, British Columbia; Geology by R. G. McConnell, 1910-1911.